Volume 22, Number 11, June 15, 1968

NUCLEAR SCIENCE ABSTRACTS

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Index References

All index entries refer the reader to volume and abstract number:

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FOURRIER, Alain
  Radioactive chain of mass number 189,  21:10023
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Personal Authors

Every author's name is indexed in the form appearing on the document abstracted:

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MONTH, M.
  Theory of gradient perturbations in AGS,  21:9872 (BNL-
    10899)
MONTH, Melvin
  Simple relativistic calculation of the electromagnetic
    form factors of the deuteron,  21:9744
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Subjects

The subject index consisting of specific materials, objects, and processes is arranged alphabetically. Modifying phrases specific to these subjects in turn are arranged alphabetically under the subjects.

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SHEEP
  radiation dosimetry in, measurement of lethal dose of x,
    21:8905(R) (AD-631189)
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    21:8905(R) (AD-631189)
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    21:8782(R) (AD-631424)
  evaluation of fallout, for fire and air blast damage,
    21:8560 (URS-658-3)
  fire resistance of components of, evaluation of,
    21:8789(R) (AD-642241)
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Corporate Authors

Technical report literature is indexed from the name of the organization or institution responsible for the issuance of the report.

8500 (Y-1561) MIXING AND SAMPLING ENRICHED ^{235}U FLUIDS IN CYLINDRICAL STORAGE CONTAINERS. Final Report. Harrell, J. E. **(Union Carbide Corp., Oak Ridge, Tenn. Y-12 Plant).** Jan. 17, 1967. Contract W-7405-eng-26. 124p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

is indexed as:

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UNION CARBIDE CORP., OAK RIDGE, TENN.  Y-12 PLANT.
  Mixing and sampling enriched 235U fluids in cylindrical
    storage containers,  21:8500 (Y-1561)
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  3311(Suppl.  21-8567   Dep. mn. CFSTI $3.00 cy, $0.65 mn
    2)
  22298        21-9915   Nucl. News, 9: No. 12, 17-21 (Dec.
                           1966)
  22298        21-9914   Nucl. News, 10: No. 1, 17-20(Jan.
                           1967)
  23267        21-9702   Phys. Rev., 152: 1171-82(Dec. 23,
                           1966)
  23267        21-8498   Dep. mn. CFSTI $3.00 cy, $0.65 mn
  23420        21-8764   Lancet, 2: 672-5(Sept. 24, 1966)
  23474        21-8528   Dep. mn. CFSTI $3.00 cy, $0.65 mn
  23478        21-8641   Dep. mn. CFSTI $3.00 cy, $0.65 mn
  23482        21-9471   Dep. mn. CFSTI $3.00 cy, $0.65 mn
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Use of funds for printing this publication approved by the Director of the Bureau of the Budget, June 28, 1966.

Volume 22, Number 11 June 15, 1968

NUCLEAR SCIENCE ABSTRACTS

CHEMISTRY

Analytical Chemistry

Refer also to abstracts 21055, 21236, 21393, 21867, 22614, and 22894.

21018 (ARH-SA-1) DETERMINATION OF AMERICIUM WITH DI-N-BUTYL-N-BUTYLPHOSPHONATE. Kerns, R. C. (Atlantic Richfield Hanford Co., Richland, Wash.). Sept. 5, 1967. Contract AT(45-1)-2130. 28p. Dep. CFSTI.

A method is described for the determination of ^{241}Am in plutonium by solvent extraction using di-n-butyl-n-butylphosphonate and alpha counting. The greatest decontamination and the best recovery of Am occurred at 12 M HNO_3, the decontamination factor being greater than 10^4. In addition, E o/a (concentration in organic phase/concentration in aqueous phase) for Am at this acid concentration is less than 10^{-2}. These circumstances will permit the determination of very small quantities of Am in large excesses of Pu. Advantages and disadvantages of the method are discussed. (P.C.H.)

21019 (BNWL-SA-1717) SOME STATISTICAL PROBLEMS IN MASS SPECTROMETRY. Jaech, John L. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). Mar. 8, 1968. Contract AT(45-1)-1830. 16p. (CONF-680308-2). Dep. CFSTI.

From 155th National Meeting of the American Chemical Society, San Francisco, Calif.

It is shown how information in sets of data on uranium isotopes may be extracted using the Poisson distribution of the pulse count data from a mass spectrometer. Four statistical problems are covered: bias control with cusum charts, comparison of two methods of reading beams, detection of abnormalities in data, and optimum allocation of effort. (D.L.C.)

21020 (HASL-184, pp I.224-45) ANALYSES OF QUALITY CONTROL SAMPLES AT HASL AND OTHER LABORATORIES DURING 1967. Hardy, E. (New York Operations Office (AEC), N. Y. Health and Safety Lab.).

Results are reported from quality control analyses for ^{90}Sr performed during 1967 on samples of bone ash, vegetable ash, powdered milk ash, ion-exchange resin used in fallout collection, and atmospheric pot samplers. Known amounts of standardized solutions of ^{89}Sr and ^{90}Sr were added to simulated pot and unexposed resin samples and analyses were performed. Measurements were also made of ^{89}Sr content of monthly fallout samples. Results obtained on natural samples and blind duplicate samples are reported. (C.H.)

21021 (K-L-6182) AUTOMATIC PROCESS CHROMATOGRAPHS FOR THE ANALYSIS OF CORROSIVE FLUORIDE GASES. Million, J. G.; Pappas, W. S.; Weber, C. W. (Oak Ridge Gaseous Diffusion Plant, Tenn.). [1968]. Contract W-7405-eng-26. 18p. (CONF-680308-4). Dep. CFSTI.

From 155th National Meeting of the American Chemical Society, San Francisco, Calif.

An automatic process gas chromatograph is described, capable of sampling from corrosive gas systems ranging in pressure from subatmospheric to several atmospheres. The instrument is mobile and essentially self-contained. Provision for column selection and for continuous control of sample pressure and flow allows application to a wide variety of problems. A special gas sampling system was selected to satisfy requirements for leak tightness in sub-atmospheric sampling. Particular attention is given to the problem of obtaining representative samples from highly reactive gas systems. Applications of instruments of this type at the Oak Ridge Gaseous Diffusion Plant include the identification of halocarbon coolant leaks into the uranium hexafluoride process gas. Special techniques yield a coolant sensitivity of 20 ppM and an analytical cycle of $1\frac{1}{2}$ minutes. (auth)

21022 (PG-Report-823) ANALYTICAL METHOD FOR THE DETERMINATION OF NON-URANIC ALPHA EMITTERS IN URANIUM PRODUCTS FROM THE REPROCESSING OF NATURAL URANIUM FUELS. (United Kingdom Atomic Energy Authority, Sellafield (England). Production Group). 1968. 8p. Dep. CFSTI. UK 1s. 9d.

The alpha emitters are coprecipitated on lanthanum fluoride and the alpha activity of the precipitate measured with a scintillation counter. The proportion of this activity originating from nonuranic alpha emitters is determined by alpha pulse height analysis. The method is applicable to solutions of depleted uranyl nitrate containing up to 300 mg of uranium per ml and is intended for the uranyl nitrate concentrate and uranium trioxide product from the Windscale Denitration Plant. (auth)

21023 (PRNC-104, pp 68-74) METHOD OF CALCULATING THE ELEMENTAL CONCENTRATION. (Puerto Rico Nuclear Center, Mayaguez).

An IBM 1401 Computer is being used to speed-up the process of calculating the concentration of elements contained in samples once they are analyzed. (M.C.G.)

21024 (PRNC-104, pp 75-82) CARBON, HYDROGEN, NITROGEN ANALYSES. (Puerto Rico Nuclear Center, Mayaguez).

A series of carbon, hydrogen, and nitrogen analyses were run on 48 air-dried individual specimens of the blue copepod Pontella mimocerami. All three elements showed a linear increase with increasing animal weight up to ~0.3 mg above which there seemed to be quite a bit of variation. The average contents were higher in females than in males. Samples that had received lipid extraction were also analyzed. (M.C.G.)

21025 (PRNC-104, pp 91-5) ACTIVATION ANALYSIS OF ALUMINUM. (Puerto Rico Nuclear Center, Mayaguez).

A limited investigation was started on the distribution patterns of aluminum in marine organisms and environmental compartments off the west coast of Puerto Rico. A nondestructive method of neutron activation analysis was developed for marine and fresh-water sediments, rocks, minerals, and modern biogenic carbonates. (M.C.G.)

21026 (PRNC-104, pp 96-8) THE RAPID SEPARATION OF ^{46}Sc IN NEUTRON ACTIVATION ANALYSIS. (Puerto Rico Nuclear Center, Mayaguez).

A method was developed for rapid separation of small amounts of scandium from large amounts of ^{47}Ca in neutron-activation analysis of biogenic carbonates for scandium. (M.C.G.)

21027 (PRNC-104, pp 99) ACTIVATION ANALYSIS OF Mn IN BIOLOGICAL SAMPLES. (Puerto Rico Nuclear Center, Mayaguez).

A method was developed for determining manganese in carbonates by neutron activation methods. (M.C.G.)

21028 (PRNC-104, pp 102-6) MODIFIED ION EXCHANGE METHOD FOR SEPARATING Cu, Fe, AND Zn FROM Sc AND THE RARE EARTHS. (Puerto Rico Nuclear Center, Mayaguez).

A method was developed that successfully gains quantitative yields of Cu, Zn, and Fe as separated from Sc, La, and Sm from biological samples ranging in dry weight from 4 to 50 mg. Each sample may be analyzed quantitatively for the 6 elements. Post-irradiation ion exchange is used in the determinations. (M.C.G.)

21029 (SC-M-67-3044) ANALYTICAL PROCEDURES FOR THE ENVIRONMENTAL HEALTH LABORATORY. Brewer, Lial W. (comp. and ed.) (Sandia Corp., Albuquerque, N. Mex.). Feb. 1968. 151p. Dep. CFSTI.

Methods are described for various determinations including: acetone acid and alkali contaminants, benzene, toluene, other aromatics, Be, chromic acid, chromates, dichromates, formaldehyde, methanol, NO_2, oil mist, ozone, phosgene, SiO_2, SO_2, and Zn in air; actinides, arsenic, enriched U, F_2, Hg, ^{210}Po, and trichloroacetic acid in urine; Be in air and on swipes; Cd and Tl in air and urine; ^{137}Cs and gross beta activity in soil, urine, vegetation, and water; Cr in urine and water; composition of organic solvents; free silica; Pb in air, urine, and on swipes; ^{24}Na in air, blood, urine, and water; ^{90}Sr in soil, vegetation, and water; total I in oil; total U on fallout trays and in soil, urine and water; and T in urine, water, and on swipes. General procedures are also described for spectrographic analysis, atomic absorption analysis, and breath analysis using the gas chromatograph. (P.C.H.)

21030 (RFP-Trans-29) ANALYSIS OF HYDROGEN PEROXIDE BY COLORIMETRY. Blanquet, P.; Dalmai, G. Translated by A. R. Kazanjian from Bull. Soc. Chim. Fr., No. 5, 419-22 (1957). 12p. Dep. CFSTI. JCL $1.60 fs, $0.80 mf.

The complex formed between uranyl ion and hydrogen peroxide in a carbonate medium was utilized to measure the hydrogen peroxide between 0 and 25 ppM. The optimum wave length is 3800 Å and Beer's law is applicable up to 0.35 milligrams of hydrogen peroxide in 25 ml. This method can be adapted to the study of products of combustion. (auth)

21031 ISOTOPIC COMPOSITION OF MAGNESIUM IN UPPER MANTLE MATERIALS AND A METEORITE. Takematsu, Noburu; Matsuo, Sadao (Tokyo Univ.). Geochem. J. (Nagoya), 1: 51-4(June 1967).

The isotopic ratios of Mg in rocks coming from the upper mantle and Bruderheim chondrite were measured by a solid-source mass spectrometer. There was no significant difference in $^{25}Mg/^{24}Mg$ and $^{26}Mg/^{24}Mg$ ratios between materials constituting the mantle and Bruderheim chondrite within the limits of 95% confidence. The standard errors of both $^{25}Mg/^{24}Mg$ and $^{26}Mg/^{24}Mg$ measurements of a sample were about 0.5%. (NSA of Japan)

21032 SPECTROGRAPHIC ANALYSIS OF SOLUTIONS OF REFRACTORY RAW MATERIALS AND PRODUCTS. Dohr, H.; Buttgeret, C. (Forschungsinst. Feuerfest-Ind., Bonn). Tonind.-Ztg. Keram. Rundsch., 90: 577-80(1966). (In German).

The sample was fused with $K_2CO_3-Na_2CO_3-Na_2B_4O_7$ (3:3:2) at 1100° for 20 min. The melt was treated with water and with HNO_3 (1:1) added dropwise, with cooling. A Cd solution was added as internal standard, and the solution was diluted to 1 liter with HNO_3 (1:1), then sprayed on to a rotating carbon electrode. The spectrum was excited with a medium-voltage spark (≈ 1500 V) with small damping and self-induction. Six materials were analyzed for Al, Ca, Cr, Fe, Mg, Mn, Ni, Si, Ti, V, and Zr. (Analytical Abstr.)

21033 COMPLEXES OF URANYL WITH PHENOLIC LIGANDS. X. SPECTROPHOTOMETRIC URANIUM DETERMINATION BY MEANS OF 5-SULFOSALICYLIC ACID. Hável, J.; Sommer, L. (Purkyne-Univ., Brno). Collect. Czech. Chem. Commun., 33: 529-48(Feb. 1968). (In German).

By exhaustive spectrophotometric investigation of the reaction of uranyl ions with 5-sulfosalicylic acid, the step-wise formation of 1:1 and 1:2 complexes in solutions with reagent excess was confirmed. On the basis of the comparison of the results of this work with older results, the method for spectrophotometric determination of uranium by means of 5-sulfosalicylic acid is discussed. (tr-auth)

21034 GAS CHROMATOGRAPHY OF URANIUM HEXAFLUORIDE AT LOW TEMPERATURES. Tsujimura, Shigeo (Japan Atomic Energy Research Inst., Tokyo); Fujisawa, Ginji; Ito, Hiroshi. J. Nucl. Sci. Technol. (Tokyo), 5: 127-31(Mar. 1968).

Gas chromatography of UF_6 at low temperature was studied using columns of polytrifluoromonochloroethylene oils as the liquid phase. The dependence of retention time of UF_6 on the degree of polymerization of oils, liquid phase loading, and kinds of solid support were studied in the temperature range between −10 and 40°C, and the most favorable conditions for quantitative analysis of UF_6 are discussed. The relation between the gas chromatographic characteristics of the columns and the BET surface area of the solid support was briefly examined. (auth)

21035 THE OSCILLOPOLAROGRAPHIC DETERMINATION OF U(VI), Mo(VI), AND V(V) WITH FERRON (7-IODO-8-HYDROXYQUINOLINE-5-SULFONIC ACID. Bertoglio Riolo, Carla; Fulle Soldi, Teresa; Spini, Giovanni (Univ., Pavia, Italy). Ann. Chim. (Rome), 58: 3-12(Jan. 1968). (In Italian).

The oscillopolarographic determination of U(VI), Mo(VI), and V(V) with ferron was studied in acetic buffered solution for metal concentrations ranging from 1.10^{-7} to 1.10^{-5} M for U(VI), from 1.10^{-7} to 1.10^{-6} M for Mo(VI), and from 4.10^{-7} to 1.10^{-6} M for V(V). (auth)

21036 ACTIVATION ANALYSIS OF THE IMPURITIES IN ALUMINUM. THE QUALITIES OF IRRADIATION SAMPLE CONTAINER MATERIALS, AND THE PROBLEMS. Bando, Shoji (Japan Atomic Energy Research Inst., Tokyo). Genshiryoku Kogyo, 13: 44-8(Aug. 1967). (In Japanese).

Activation analyses were carried out on some Al samples to select the material with relatively few impurities with respect to induced activities. Methods of analysis for short-lived nuclides, Cu, Ga, Mn, and Na by nondestructive techniques and by chemical separations and for long-lived nuclides, Co, Cr, Fe, Hf, Sb, Sc, and Zn, are described. Interfering nuclides and reactions were investigated. Particular attention is given to the activation of impurities in aluminum for use in irradiation containers. (NSA of Japan) (TSS)

21037 RAPID SPECTROPHOTOMETRIC DETERMINATION OF PLUTONIUM. Andersson, Lars-Henrik; Bauren, Eva-Britt. FOA (Forsvarets Forsk.) Rep., 1: 1-4(Dec. 1967).

A method for the rapid determination of plutonium in solutions of nitric acid, the reduction of plutonium ions to Pu(III) ions and the measurement of the resulting color of 567 nm, was investigated. Only moderate precision was aimed at. The reducing agent was ascorbic acid. The effects of the amount of reducing agent added, the nitric acid concentration, and the presence of certain impurities were studied. The method was applied to solutions containing 0.5 to 10 mg plutonium per g of solutions (2 to 40 mMole). If reasonable care is taken to control the nitric acid concentration of the solutions, a standard deviation of 0.07 mg plutonium per g of solution (0.3 mMole) may be obtained with a single measurement. Sulfamic acid was added to the solution to be reduced to increase its stability after reduction. The time required for a determination is approximately 15 minutes. (auth)

21038 RHENIUM DETERMINATION BY NEUTRON-ACTIVATION METHODS. Gureev, E. S.; Islamov, T.; Miranskii, I. A.; Muminova, M. F.; Miroshnikov, V. S. (Inst. of Nuclear Physics, Tashkent). Izv. Akad. Nauk Uzb. SSR, Ser. Fiz.-Mat. Nauk, No. 6, 65-7(1967). (In Russian).

Descriptions are given of rhenium determination in molybdenum by neutron activation with corrections for interfering self-screened neutrons, competing reactions, and formation of radiotechnetium in $^{98}Mo(n,\gamma)^{99}Mo \xrightarrow{\beta^-,\ 67\ hr} {}^{99m}Tc$ reactions, which strongly interferes with γ-spectrometric determination of rhenium. Carrier-free ^{183}Re ($T_{\frac{1}{2}}$ = 70 days) was used as a tracer. After chemical purification the rhenium-containing specimen and Mo standard were irradiated in a reactor with γ-spectrometric determination 5 min following the irradiation. The sensitivity of rhenium determination was equal to 1 to 2×10^2 mkg in 5 ml of the initial solution and took 3 hr. (R.V.J.)

21039 SILICON DETERMINATION IN A SYNTHETIC CORUNDUM BY ACTIVATION METHODS USING 14.5-MeV NEUTRONS. Sattarov, M.; Talanin, Yu. N.; Yunusov, M. (Inst. of Nuclear Physics, Tashkent). Izv. Akad. Nauk Uzb. SSR, Ser. Fiz.-Mat. Nauk, No. 6, 50-3(1967). (In Russian).

Silicon determination in a synthetic corundum ($\alpha - Al_2O_3$) without its degradation was achieved by irradiation of specimens with fast 14.5-MeV neutrons. Interactions of the 14.5-MeV neutrons with silicon and aluminum occurred by (n,p), (n,α), and (n,γ) processes. The best results were obtained with the ^{28}Si (n,p)^{28}Al reaction. The specimens were irradiated in a (D−T) neutron generator by $\approx 10^9$ neut/cm^{2}sec neutron flux, gamma spectra recorded by a single-crystal γ spectrometer consisting of a NaI(Tl) crystal, a photomultiplier, and a hundred-channel pulse analyzer. The spectrometer was standardized according to the ^{51}Cr(0.32 MeV), ^{37}Cr(0.661 MeV), ^{60}Co(1.17 and 1.33 MeV), and ^{24}Na(1.37 and 2.75 MeV) isotope γ lines and had a resolving power of 11% for ^{137}Cs. (R.V.J.)

21040 PAPER CHROMATOGRAPHIC METHOD FOR THE SEPARATION AND IDENTIFICATION OF TITANIUM, URANIUM, THORIUM, AND ZIRCONIUM AS THEIR THIOCYANATE COMPLEXES. Verma, M. R.; Gupta, P. K. (National Physical Lab., New Delhi). Curr. Sci. (India), 37: 194-5(Apr. 5, 1968).

One drop of each metal solution was applied to filter paper.

Potassium thiocyanate and nitric acid were mixed with butanol. The organic layer was used as the eluant. The spots of titanium and uranium could be seen visually. After spraying with oxine and ammonia, the spot of zirconium showed bright fluorescence, whereas uranium, titanium, and thorium appeared as dark spots under ultraviolet light. (M.C.G.)

21041 INVESTIGATION OF THE USE OF DERIVATIVE NEUTRON ACTIVATION ANALYSIS FOR DRUG ASSAY. Skinner, W. A.; Leaffer, M. A.; Parkhurst, R. M. (Stanford Research Inst., Menlo Park, Calif.). J. Pharm. Sci., 57: 338-40 (Feb. 1968).

The use of neutron activation analysis for assay of chlorine- or bromine-containing drugs or derivatives of drugs was investigated. The ubiquitous nature of chloride greatly limited the use of this analytical method for chlorine-containing derivatives because of the background problem. Bromine-containing derivatives of aspirin and salicylic acid were prepared for neutron activation analysis, but again background bromide and interfering substances limited detection to 1×10^{-2} mcg of bromide. Sensitivity of this analytical method is not comparable to that attainable with gas chromatography or spectrofluorometry. (auth)

21042 NONDESTRUCTIVE DETERMINATION OF SILICON (SILICA) IN MARINE SEDIMENTS BY FAST NEUTRON ACTIVATION. Shigematsu, Tsunenobu; Fujino, Osamu; Honjo, Takaharu (Shigematsu Lab., Japan). Bull. Inst. Chem. Res., Kyoto Univ., 45: 299-306 (Sept. 1967).

Silica in marine sediment samples was determined by 14-MeV neutron activation. The powdered sample (1 g) was irradiated in a neutron flux of about 2×10^5 n/cm^2 · sec. The gamma spectrum of the 2.27 min ^{28}Al was measured and the decay of the 1.78 MeV photo-peak was followed. The results agreed with the value obtained colorimetrically. The error was about 5%. (auth)

21043 ACTIVATION ANALYSIS OF LANTHANUM AND EUROPIUM IN SEA WATER AND LAKE WATER. Shigematsu, Tsunenobu; Tabushi, Masayuki; Aoki, Toru; Fujino, Osamu; Nishikawa, Yasuharu; Goda, Shiro (Kinki Univ., Japan). Bull. Inst. Chem. Res., Kyoto Univ., 45: 307-17 (Sept. 1967).

Lanthanum and europium in sea water and lake water were determined by thermal neutron activation analysis. Convenient pre- and post-irradiation procedures were developed. Rare earth elements were concentrated and separated by coprecipitating with ferric hydroxide or calcium oxalate. The precipitates were irradiated for one hour in a neutron flux of 5×10^{12} n/cm^2 · sec. After a few hours cooling, the rare earth activities were separated by precipitating with lanthanum oxalate from the solution containing various hold-back carriers and citric acid. Decays of the 0.8 ~ 1.2 MeV photo peak of ^{152m}Eu (plus ^{140}La) and the 1.6 MeV peak of ^{140}La were followed. The analytical results were as follows: 2.9 to 4.5×10^{-2} μg La/l and 1.0 to 1.8×10^{-3} μg Eu/l in sea water; 4.0 to 4.8×10^{-2} μg La/l and 0.9 to 1.2×10^{-3} μg Eu/l in lake water. The Eu/La ratios were estimated to be 0.043 ± 0.004 for sea water (13 determinations) and 0.022 ± 0.002 for lake water (4 determinations) (auth)

21044 RAPID DETERMINATION OF COPPER IN PLANTS BY NEUTRON ACTIVATION ANALYSIS. Grimanis, Apostolos P. (Democritos Nuclear Research Center, Athens). Talanta, 15: 279-85 (Mar. 1968).

A rapid and simple neutron-activation method was developed for the determination of copper in plant leaves. Irradiated samples were dissolved in a mixture of fuming nitric acid, 70% perchloric acid, and concentrated sulphuric acid in the presence of copper carrier solution. The copper in the resulting solution was extracted as copper cupferronate into chloroform and back-extracted into concentrated ammonia solution. The copper was precipitated as sulphide with 3% aqueous thioacetamide solution and the precipitate dissolved in nitric acid. The induced activity of ^{64}Cu in the resulting solution was counted with a 400-channel analyzer. The photopeak of the annihilation energy of ^{64}Cu at 0.51 MeV was compared with that of a copper standard processed in the same manner. After counting, the chemical yield of the separated copper was found by re-irradiating aliquots of the copper nitrate solution and comparing the induced activity of ^{66}Cu at 1.04 MeV with that of another standard processed in a similar manner. The time required to complete the analysis, including the second irradiation and all radioactivity measurements, was about 25 min. The accuracy of the method was checked by analyzing a biological standard of known copper content. The proposed method was successfully applied to the determination of copper in the leaves of 10 different plants (copper content 4 to 30 ppM). (auth)

21045 DETERMINATION OF NITROGEN IN AN ALUMINIUM-KILLED STEEL BY AN ISOTOPE-DILUTION METHOD USING Al^{15}N. Furuya, Keiichi; Okuyama, Shoichiro; Tachikawa, Takashi; Kamada, Hitoshi (Tokyo Univ.). Talanta, 15: 327-32 (Mar. 1968).

The results obtained by the method described were in agreement with those obtained by chemical determination, whereas the vacuum fusion method with iron and platinum baths, and the isotope-dilution method using gaseous ^{15}N-enriched nitrogen, did not give accurate results. (auth) (UK)

21046 A REPORT ON VERY LOW LEVEL POLONIUM DETERMINATION IN AIRBORNE DUSTS BY ELECTROCHEMICAL DISPLACEMENT. Abe, M.; Abe, S. (National Inst. of Radiological Sciences, Chiba, Japan). Health Phys., 14: 373-5 (Apr. 1968).

Experiments were made on the recovery of very low level Po in airborne dusts by the use of electrochemical displacement. The recovery was measured in two ways; either by the tracer method or the filter method. The recovery percentage determined by the filter method was 84%, even at minimum, and is near 100% for the other samples. The recovery at 10^{-12} and 10^{-13} Ci of ^{210}Po by the tracer method could be considered as being better than 90%. (P.C.H.)

21047 SEPARATION OF FLUORINE BY WILLARD–WINTER DISTILLATION AND ITS DETERMINATION BY TITRATION WITH THORIUM NITRATE OR BY SPECTROPHOTOMETRIC MEASUREMENT. Andersson, Lars-Henrik; Gelin, Birgit. FOA(Forsvarets Forsk.) Rep., 1: 1-5(Nov. 1967).

The method introduced by Willard and Winter in 1933 for the separation of fluorine by distillation does not give satisfactory results in the presence of metals forming strong complexes with fluoride ions. By the use of impure chemicals or by dissolution from the glass walls of the distillation apparatus, traces of such metals may be introduced during the separation procedure, preventing complete recovery of the fluorine. When purified chemicals and a distillation apparatus made of fused silica were used, separations with recoveries around 99.5% of the added amount of fluorine were possible. Aluminum prevents complete separation, as do uranium and plutonium in low valence states. Interference from the two latter elements can, however, be eliminated by oxidation to U(VI) and Pu(VI), respectively. (auth)

21048 PROCESS FOR THE PREPARATION OF SAMPLES FOR MEASUREMENT OF ISOTOPES BY MEANS OF MASS SPECTROMETERS. (to United Kingdom Atomic Energy Authority). British Patent 1,104,518. Feb. 28, 1968. Priority date Aug. 28, 1964, Austria.

A process for the preparation of a sample of solid substance of low volatility for mass spectrometric analysis consists of heating and evaporating the sample by virtue of its own electrical resistance by passing an electric current between electrodes applied to the surface of the sample. The heating and evaporation are carried out in a vacuum or in a protective gas atmosphere directly onto the filament of an ion source. (B.L.M.)

21049 METHOD AND APPARATUS FOR THE EXAMINATION OF SAMPLES OF NUCLEAR FUEL OR WHOLE NUCLEAR FUEL ELEMENTS WITHOUT DESTRUCTION THEREOF. Wienzierl, Peter; Putz, Franz (to Osterreichische Studiengesellschaft fuer Atomenergie GmbH). British Patent 1,103,924. Feb. 21, 1968. Priority date Aug. 27, 1964, Austria.

A nondestructive method for determination of given fissionable materials in reactor fuel elements consists of feeding the radiation from the samples subjected to certain different energy neutrons to one or more receivers that are sensitive to the resonance energies of the materials to be detected to determine the transmission of the sample for the different neutron energies. The range of neutron energies used is that for which the material to be determined has a resonant absorption. From a comparison of the appearances of radiation energies on the receivers, a ratio of the proportions of the fissionable materials is deduced. (B.L.M.)

21050 INERT RADIOACTIVE FISSION GAS SAMPLER. Landolt, Robert R. (to United States Atomic Energy Commission). U. S. Patent 3,372,274. Mar. 5, 1968.

A method was developed for measuring the radioactivity of an inert fission gas sample. All particulate matter is removed from the sample to provide a purified sample. The purified sample is then stored in an airtight resiliently expandable container for a predetermined time, after which it is exhausted and particulate daughter products resulting from decay events occurring within the container are collected. The radioactivity of the collecting means and the container is measured to determine the amount of the particulate daughter present in the exhaust mixture to provide a measure of the radioactivity of the inert fission gas sample. (AEC)

21051 TABLE OF NEUTRON ACTIVATION CONSTANTS. Baumgaertner, Franz. Buchreihe der Atomkernergie. Band

4. Munich, Verlag Karl Thiemig KG, 1967. 47p. DM 5,80. (In German and English).

Translated by Harald Ramdohr.

For simplification of activity calculations for neutron irradiations, the specific saturation activities of the (n, γ) products for the natural elements have been compiled, as well as the specific activities per second, minute, hour, and day irradiation time. With this compilation it is possible by two simple multiplications, i.e., by the atomic weight and by the irradiation time, to evaluate very quickly the activities of the individual radionuclides for a neutron irradiation of 10^{13}n/cm^2 sec. As far as resonance activation integrals and cross sections of the (n,2n)-, (n,p), and (n,α) reactions effective for the fission neutron spectrum were known, activities formed by these processes were taken into account as well as activities eventually formed by β decay. In addition the most predominant radiation transitions of the radionuclides are given for the evaluation of activities. (auth)

Inorganic, Organic, and Physical Chemistry

Refer also to abstracts 21093, 21171, 21646, 21984, 22898, and 22919.

21052 (CONF-660553-6) ANALISIS POR ESPECTROMETRIA DE MASAS DE PRODUCTOS VOLATILES PROCEDENTES DE LA PIROLISIS DE POLIFENILOS. (Mass Spectroscopic Analysis of the Volatile Products of Pyrolysis of Polyphenyls). Sanz, H. G. (Junta de Energia Nuclear, Madrid (Spain)). [1966]. 10p. (In Spanish). Dep.

From Panel on Use of Organic Liquids as Reactor Coolants and Moderators, Vienna, Austria.

Mass spectrometry was applied to analyzing the volatile components of the products of polyphenyl pyrolysis. In the gaseous fraction the following components were found: hydrogen, paraffins C_1 to C_4, olefins C_2 to C_4, alcohol benzenes C_6 to C_8, carbon monoxide and dioxide, nitrogen, argon, air, and water. A total of 18 components was identified. In the liquid fraction the principal component was benzene, with small quantities of toluene, ethylbenzene, xylenes, normal and isopropyl benzene, naphthalene, and biphenyl. The experimental conditions and the methods of calculation used for the two types of samples, are described. (auth)

21053 (CONF-660553-5) SEPARACION DE TERFENILOS HIDROGENADOS POR CROMATOGRAFIA DE GASES E INTERPRETACION DE SUS ESPECTROS DE INFRARROJO Y ULTRAVIOLETA. (Separation of Hydrogenated Terphenyls by Gas Chromatography and Interpretation of Their Infrared and Ultraviolet Spectra). Gasco Sanchez, L.; Parellada Bellod, R. (Junta de Energia Nuclear, Madrid (Spain)). [1966]. 15p. (In Spanish). Dep.

From Panel on Use of Organic Liquids as Reactor Coolants and Moderators, Vienna, Austria.

In the separation of commercial mixtures of hydrogenated terphenyls [HB-40 (Monsanto) and OMP-H (Progil)] satisfactory results were obtained, as regards the collection of fractions, using columns 2 m in length packed with 20% Apiezon L on Chromosorb and, as regards total separation, using Apiezon L Macrogolay columns. The relative retentions, determined at temperatures between 185 and 300°C, for the components of a mixture of triphenylmethane and anthracene were investigated in columns of Apiezon L, silicone SE-30, SE-31 and W-95, and silicone oil SF-96. The infrared and ultraviolet spectra of the components were studied, the following structures being assigned to them in the order of their appearance in the chromatogram: o-terphenyl, o-phenylcyclohexylbenzene, m-dicyclohexylbenzene, phenylcyclohexylcyclohexane, p-dicyclohexylbenzene, m-phenylcyclohexylbenzene, and p-phenylcyclohexylbenzene. (auth)

21054 (ORO-1797-11, pp 1-113) LANTHANIDE AND ACTINIDE CHEMISTRY. (Florida State Univ., Tallahassee. Dept. of Chemistry).

Experimental determinations of the thermodynamic parameters of the trivalent lanthanide ions with a series of chelates were completed. Stability constants and enthalpies of rare earth complexes with polyaminocarboxylic acids were determined. Stability constants were also determined for α-mercapto and β-mercapto propionate complexes of rare earths and calorimetric studies were carried out. The thermodynamic parameters of hydration were calculated for lanthanide iodates. An attempt was made to develop a versitile electrode system that will respond to polyvalent ions such as lanthanides and thorium. A liquid ion exchange system was investigated. Variations in the oscillator strengths of the "hypersensitive" $^4I_{\frac{9}{2}} \rightarrow {}^2G_{\frac{7}{2}}$, $^4G_{\frac{5}{2}}$ transition of some complexes of Nd^{3+} are discussed. It was concluded that the phenomenon of "hypersensitivity" can be explained by the inclusion of covalency within the framework of a vibronic mechanism. (M.C.G.)

21055 (TID-24336) LOW TEMPERATURE SHRINKAGE OF THORIA GEL. II. SHRINKAGE MODEL. Technical Report Number XXXII. Chang, R. K.; Olson, F. A.; Wadsworth, M. E. (Utah Univ., Salt Lake City. Inst. of Metals and Explosives Research). Jan. 31, 1967. Contract W-7405-eng-26; Subcontract 2176. 52p. Dep. CFSTI.

For Oak Ridge National Lab., Tenn.

Shrinkage data for thoria gels of 0.15 and 0.20 NO_3/ThO_2 mole ratios showed a linear relation between normalized weight loss and shrinkage with almost the same value for the constant relating these two parameters found previously for gels of 0.1 NO_3/ThO_2 ratio. Gas chromatographic analysis of the chemisorbed gases desorbed during shrinkage showed CO_2, NO_2, and H_2O decreasing in the order given. During shrinkage the bonding of the 70 Å radius thoria gel particles change from van der Waals to chemical bonds. The HNO_3 group then migrates to an exposed surface site to produce NO_2 and possibly H_2O and undergo weight loss. The possibility of surface hydroxyl as well as surface carbonate groups producing gel particle bonding by other mechanisms is also presented. Reaction mechanisms are given. (auth)

21056 (UCRL-17961) MOLECULAR BEAM STUDIES OF SCANDIUM MONOFLUORIDE. Green, David W. (California Univ., Berkeley. Lawrence Radiation Lab.). Jan. 1968. Contract W-7405-eng-48. 79p. Dep. CFSTI.

Thesis. Part I.

The molecular beam method used previously to fix the electronic groundstate of lanthanum monoxide was modified and extended to scandium monofluoride. King furnace equilibrium studies of the intensities of the green $^1\Pi - {}^1\Sigma^+$ and red $^3\phi - {}^3\Delta$ transitions gave the relative transition probabilities from both absorption and emission. From this data the expected relative intensity of the transitions in the molecular beam was calculated assuming no radiative intersystem decay. The relative fluorescent intensity at various molecular beam path lengths indicates that both the $^1\Sigma^+$ and $^3\Delta$ states of ScF persist at least as long as 10^{-4} seconds. A maximum energy separation has been estimated to be 3,000 K (cm^{-1}). The thermodynamic free-energy function is dependent upon the degeneracies and energies of these low-lying electronic states. It was indicated that the partition function should include electronic, vibrational, and rotational contributions from both the $^1\Sigma^+$ and $^3\Delta$ states. In addition, an unobserved $^1\Delta$ state should be thermodynamically important. Free-energy functions were calculated using the best data available. It was estimated that the $^1\Pi - {}^1\Delta$ transition has a small f-value and will be weak in emission compared to the $^1\Pi - {}^1\Sigma^+$. The ratio of the f_{abs} value of the $^3\phi - {}^3\Delta$ to that of the $^1\Pi - {}^1\Sigma^+$ is 0.8 ± 3. (auth)

21057 REGULAR SOLID SOLUTIONS OF $U_{2+x}-Sc_2O_3$ COMPOUNDS. Trzebiatowski, Wlodzimierz; Horyn, Roman Inst. of Inorganic Chemistry, Warsaw). Rocz. Chem., 41: 1711-20 (1967). (In Polish).

Three kinds of nonstoichiometric solid solutions of fluorite structure in $UO_{2+x}-Sc_2O_3$ system were obtained and the type of structure defects was ascertained. (auth)

21058 THE ISOTOPIC EXCHANGE REACTION OF OXYGEN IN THE CO_2-NiO/Ni SYSTEM. Mercea, V.; Farkas, A.; Olariu, A. (Inst. of Atomic Physics, Cluj). Rev. Roum. Phys., 12: 405-20(1967).

The isotopic exchange reaction between CO_2 and NiO labeled with ^{18}O was studied. Two different mechanisms were established at about 300°C. The first is a reversible absorption-desorption of CO_2. The second is an oxidation-reduction process which represents only a fraction of the total reaction. The exchange reaction underwent two different kinetic stages. The first was a rapid chemisorption on the surface, the second was a slow diffusion into the depth of the oxide layer. The reaction velocities did not seem to depend on the thickness of the initial oxide layer. Values of rate constants of the two steps of reaction were determined, and the experimental equipment is described. (auth)

21059 NAME AND THE PREPARATION OF ATOMIC NUMBER 102 ELEMENT. Tsu, Ying. Hua Hsueh Tung Pao, No. 4, 39-40(Apr. 1960). (In Chinese).

A brief historical review is given of the discovery of element 102. The nuclear reactions and physical properties of this element are discussed. (JPRS) (TSS)

21060 LANTHANIDE COMPLEXES. V. COMPLEXES OF YTTRIUM AND LANTHANIDE NITRATES WITH TRIPHENYLARSINE OXIDE. Cousins, D. R.; Hart, F. A. (Queen Mary Coll., London). J. Inorg. Nucl. Chem., 29: 2965-74(Dec. 1967).

Complexes of triphenylarsine oxide with yttrium and lanthanide nitrates were prepared and studied. The following stoichiometries were obtained: $M(NO_3)_3(OAsPh_3)_2EtOH$, $M(NO_3)_3(OAsPh_3)_3$ and $M(NO_3)_3POAsPh_3)_4$. Triphenylarsine oxide was found to be more strongly bound to these metal ions than is triphenylphosphine oxide; the metal–ligand bond is almost entirely of an ion–dipole character. The ir spectra are discussed, especially with respect to the detailed behavior of ν_{AsO}. (auth) (UK)

21061 PREPARATION AND SOME PROPERTIES OF THE LANTHANIDE OXIDECARBIDES, Ln_4O_3C. Butherus, A. Daune; Eick, Harry A. (Michigan State Univ., East Lansing). Contract AT(11-1)-716. J. Amer. Chem. Soc., 90: 1715-18(Mar. 27, 1968). (COO-716-030).

A series of lanthanide carbide oxides (Ln = La, Nd, Gd, Ho, Er) of fcc symmetry were prepared by reducing the sesquioxide with appropriate mixtures of graphite and the corresponding lanthanide metal. The neodymium analog, which was studied extensively, was found to have the approximate stoichiometry Nd_4O_3C. The X-ray powder diffraction pattern of this phase was indexable on cubic symmetry and had a lattice parameter, $\alpha_0 = 5.1407 \pm 0.0001$ Å. The X-ray intensities were consistent with a NaCl-type lattice. Vapor-phase chromatographic analysis of the hydrolysis products suggested the presence of C^{4-} ions in the structure. Data presented indicate that this is a carbon-stabilized monoxide phase which is common to the lanthanide series. (auth)

21062 MECHANISMS OF ELIMINATION REACTIONS. X. SUBSTITUENT, ISOTOPE, AND SOLVENT EFFECTS IN E2 REACTIONS OF SOME 2-ARYLETHYLTRIMETHYLAMMONIUM BROMIDES. Saunders, William H. Jr.; Bushman, Donald G.; Cockerill, Anthony F. (Univ. of Rochester, N. Y. Univ. of Essex, Eng.). J. Amer. Chem. Soc., 90: 1775-9(Mar. 27, 1968).

Rates of reaction were determined for a number of 2-arylethyltrimethylammonium bromides with sodium ethoxide in ethanol and sodium t-butoxide in t-butyl alcohol. The reactions in ethanol followed a normal second-order rate law, but in t-butyl alcohol, an assumed order of 1.5 in 2-phenylethyltrimethylammonium bromide was required to give a steady rate constant. In the presence of excess benzyltrimethylammonium chloride, the reaction did show the expected first-order dependence on both substrate and base. It is suggested that the base is present as sodium t-butoxide ion pairs which are converted to the more reactive free t-butoxide ion by quaternary ammonium salt. In both solvents, the rates for para-substituted 2-phenylethyltrimethylammonium bromides fit the Hammett equation. The ρ values and the β-deuterium isotope effects suggest that there is less proton transfer and less carbanion character in the transition state in t-butyl alcohol than in ethanol. (auth)

21063 ELECTROPHILIC SUBSTITUTION AT SATURATED CARBON. XXXV. MECHANISTIC COMPONENTS IN BASE-CATALYZED RACEMIZATION AND ISOTOPIC EXCHANGE OF 4-BIPHENYLYLMETHOXYPHENYLMETHANE IN t-BUTYL ALCOHOL-O-d. Kollmeyer, Willy D.; Cram, Donald J. (Univ. of California, Los Angeles). J. Amer. Chem. Soc., 90: 1779-84(Mar. 27, 1968).

The syntheses of optically active 4-biphenylylmethoxyphenylmethane (I-h) and 4-biphenylyldeuteriomethoxyphenylmethane (I-d) are described. The kinetics of racemization and isotopic exchange of (−)-I-h in t-butyl alcohol-O-d–potassium t-butoxide were studied, as well as of racemization of (+)-I-d in the same medium. Rate constants for isotopic exchange of (±)-I-h and for racemization of (+)-I-d in this medium were determined. The variation with time of the optical activity of (−)-I-h was followed, and the results were demonstrated to be compatible with a kinetic model which provides for dissection of data into mechanistic pathways for isotopic exchange with retention and with inversion of configuration. The kinetic isotope effect for racemization in deuterated solvent at 116°C was $(k^H/k^D)_\alpha = 2.7$. At this temperature, the rate constant for isotopic exchange with retention exceeded that for isotopic exchange with inversion by a factor of 33. The mechanisms of the exchange and racemization reactions are discussed. (auth)

21064 ELECTROPHILIC SUBSTITUTION AT SATURATED CARBON. XXXVI. CORRELATIONS BETWEEN RATES OF POTASSIUM METHOXIDE CATALYZED HYDROGEN–DEUTERIUM EXCHANGE REACTIONS OF CARBON ACIDS AND H_-. Kollmeyer, Willy D.; Cram, Donald J. (Univ. of California, Los Angeles). J. Amer. Chem. Soc., 90: 1784-91(Mar. 27, 1968).

Rate constants for isotopic exchange of triphenylmethane and diphenylmethane and racemization of (−)-4-biphenylylmethoxyphenylmethane and (+)-4-biphenylylmethoxyphenyldeuteriomethane in methanol-O-d-dimethyl sulfoxide-d_6 (75:25, by volume) catalyzed by potassium methoxide were measured. Increases in the apparent kinetic molecularity of the catalyst and observed second-order rate constants were noted as the catalyst concentration was raised. The rate data correlated with the reported thermodynamic behavior of methanolic potassium methoxide solutions as measured by the acidity function, H_-. The theoretical basis and qualitative limitations of such rate correlations with H_- are discussed. In an alternative treatment, the kinetic data were fitted to a rate equation of the form, rate = $k_2(RH)(B) + k_3(RH)(B)^2$, where RH is the substrate, and B is the base. The two kinetic components were interpreted in terms of free carbanions and potassium carbanide ion pairs as reaction intermediates. (auth)

21065 ELECTROPHILIC SUBSTITUTION AT SATURATED CARBON. XXXVII. A KINETIC–THERMODYNAMIC ACIDITY CORRELATION OF CARBON ACIDS. Cram, Donald J.; Kollmeyer, Willy D. (Univ. of California, Los Angeles). J. Amer. Chem. Soc., 90: 1791-7(Mar. 27, 1968).

Rate constants and activation parameters for potassium methoxide catalyzed exchange of fluorene, 9-phenylxanthene, 4-biphenylyldiphenylmethane, triphenylmethane, and diphenylmethane with methanol-O-d-dimethyl-d_6 sulfoxide (75:25 by volume) were measured and extrapolated to 75°C. These kinetic acidities varied by a rate factor of ca. 10^7 and were correlated by the Brønsted relationship with reported thermodynamic acid dissociation constants that varied by a factor of about 10^{10}. Substrate kinetic isotope effects for racemization of 2-(N,N-dimethylcarboxamido)-9-methylfluorene ($k_H/k_D = 6.75$ at 25°C) and 4-biphenylylmethoxyphenylmethane ($k_H/k_D = 2.5$ at 126°C) in the same medium were also measured. The curvature in the Brønsted plot coupled with the variation of the kinetic isotope effect and changes in activation parameters with pK of the carbon acids are interpreted in terms of changes in mechanism that occur for the isotopic exchange reaction as the ΔpK_a's (pK of carbon acid–pK_a of methanol) change. (auth)

21066 AROMATIC OXYGENATION WITH DIISOPROPYL PEROXYDICARBONATE–CUPRIC CHLORIDE. ISOTOPE EFFECTS AND RELATIVE RATES. Kurz, Michael E.; Kovacic, Peter; Bose, Ajay K.; Kugajevsky, Irene (Case Western Reserve Univ., Cleveland. Stevens Inst. of Tech., Hoboken, N. J.). J. Amer. Chem. Soc., 90: 1818-22(Mar. 27, 1968).

A scheme involving reversible addition by the isopropoxycarboxy radical to the aromatic nucleus followed by oxidative conversion to ester by the metal salt is presented for oxygenation with diisopropyl peroxydicarbonate–cupric chloride. This approach is compatible with results from nonmetallic oxidants. The absence of a primary isotope effect with benzene–hexadeuteriobenzene was demonstrated for the ester product, which is construed as evidence for the effectiveness of cupric salt oxidation of the radial adduct. Prior literature analogy is pointed out. The roles of ligand transfer and electron transfer in oxidation of the substituted cyclohexadienyl radical are discussed with cupric chloride and cupric perchlorate as representative cases. The relative rates and isomer distributions are indicative of the electrophilic nature of the attacking radical. (auth)

21067 ACIDITY OF HYDROCARBONS. XXVII. PROTON EXCHANGE RATES OF FLUOROBENZENE WITH LITHIUM CYCLOHEXYLAMIDE. Streitwieser, A. Jr.; Mares, F. (Univ. of California, Berkeley). J. Amer. Chem. Soc., 90: 655-8 (Jan. 31, 1968).

Deuterium and tritium exchange in aryl positions of fluorobenzene and benzotrifluoride were studied with lithium cyclohexylamide in cyclohexylamine at 25°. Rates for D and T exchange relative to benzene are: fluorobenzene −2, 6.3×10^1, 3.4×10^1; −3, 107,86; −4, 11.2,9.1; benzotrifluoride −3, 580,390. These rates are in qualitative agreement with previous work and are interpreted with a field effect model for inductive effects. 2,5-Difluorotoluene-α-d was found to exchange 350 times faster than toluene-α-d. (auth)

21068 ACIDITY OF HYDROCARBONS. XXVIII. HYDROGEN ISOTOPE EXCHANGE OF POLYFLUOROBENZENES WITH SODIUM METHOXIDE IN METHANOL. Streitwieser, A. Jr.; Hudson, J. A.; Mares, F. (Univ. of California, Berkeley). J. Amer. Chem. Soc., 90: 648-51(Jan. 31, 1968).

Rates of hydrogen isotope exchange with sodium methoxide–methanol of pentafluorobenzene, the tetrafluorobenzenes, and 1,3-difluorobenzene were studied. The results gave the following log partial rate factors at 40°: ortho, 5.25; meta, 2.07; para, 1.13. The exchange reaction of pentafluorobenzene showed no primary isotope effect and appeared to be of the internal return type. The relative rates were found to be approximately equal to the relative equilibrium acidities. (auth)

21069 REACTIONS OF CHLORIDE ION WITH 5-METHYL-2-CYCLOHEXENYL CHLORIDE. A DETAILED MECHANISM FOR ANION-PROMOTED ALLYLIC REARRANGEMENT. Lesnini, David G.; Buckley, Paul D.; Noyes, Richard M. (Columbia Univ.,

New York. Univ. of Oregon, Eugene). J. Amer. Chem. Soc., 90: 668-78(Jan. 31, 1968).

5-Methyl-2-cyclohexenyl chloride (indexed as 6-chloro-4-methylcyclohexene) in the presence of a chloride salt can undergo simultaneous cis-trans isomerization, isotopic exchange of chloride ion, and racemization. All of these reactions are first order in tetraethylammonium chloride in acetonitrile at 65° and constant ionic strength. The most important reaction in the system is S_N2 substitution on the same carbon initially containing chlorine. The rate of cis-trans isomerization is equal to that of isotopic exchange but less than that of mutarotation plus racemization; these observations rule out major contributions from S_N2' mechanisms. The best explanation of the racemization reaction apparently involves a "sandwich" transition state in which a chloride ion on the opposite side of the ring promotes racemization of a cis allylic chloride molecule. The results do not contribute to the original objective of estimating life-times of intimate and solvent-separated ion pairs, and studies by other investigators suggest that such lifetimes may be very short in aprotic solvents. (auth)

21070 REMOTE SECONDARY DEUTERIUM ISOTOPE EFFECTS. Jewett, J. G.; Dunlap, R. P. (Ohio Univ., Athens). J. Amer. Chem. Soc., 90: 809-10(Jan. 31, 1968).

Secondary steric isotope effects in the solvolysis of dimethylneopentylcarbinyl chloride (indexed as 2-chloro-2,4,4-trimethylpentane) and its δ-nondeuterated analog were studied. Results indicate that nonbonded interactions of the magnitude involved in usual solvolytic systems have a negligible effect on β-C−H force constants and that a hyperconjugation model best explains β-secondary isotope effects on solvolytic reactions. (J.G.B.)

21071 ION EXCHANGE CHROMATOGRAPHY OF RARE EARTHS IN AQUEOUS ORGANIC MEDIA. V. STABILITY CONSTANTS OF EUROPIUM WITH α-HYDROXYISOBUTYRIC ACID IN THE SYSTEM METHANOL−WATER. Alexa, J. (Inst. of Nuclear Research, Prague). Collect. Czech. Chem. Commun., 33: 188-92(Jan. 1968).

The results of measurement of stability constants of europium complexes with α-hydroxyisobutyric acid in media, containing water and 16.67, 33.33, 50.00, 66.67, and 83.33 wt % of methanol as solvent, are presented. The study of the dependence of the europium sorption on an ion exchanger from media having different ligand molarity resulted in the verification of the assumption that the stability constants are logarithmic function of the reciprocal value of the dielectric constant in all the range of methanol concentrations in the system studied. (auth)

21072 THE EFFECT OF ANODIC PASSIVATION ON THE ADSORPTION OF RADIOACTIVE SUBSTANCES ON THE SURFACE OF PLATINUM. Madi, Istvan; Bolyos, Andras. Magy. Kem. Foly., 74: 7-14(Jan. 1968). (In Hungarian).

The kinetics of the adsorption of various radioactive ions ($^{212}Pb^{2+}$, $^{111}Ag^{+}$, and $^{204}Tl^{+}$) were investigated on nonpassivated and anodically passivated platinum surfaces. The results show that there is a marked difference between the spontaneous deposition of radioactive ions on a nonpassivated and on an anodically passivated platinum surface, and this difference can be traced back to the greater adsorption capacity of radioactive ions on anodically passivated platinum. The experiments showed that the hydrogen ion concentration of the solution has an effect on the adsorption as a function of time, on the equilibrium distribution coefficient, and on the number of active centers on the surface of the platinum. At higher hydrogen ion concentrations, the active centers are increasingly engaged by the adsorption of hydrogen ions, consequently the adsorption of the radioactive substance is suppressed. The change of the equilibrium distribution coefficient characteristic of the adsorption of $^{212}Pb^{2+}$ was investigated as a function of the Pb^{2+} ion concentration. The Langmuir isotherm fits the adsorption data. The experimental results show that the number of active centers is greater on a passivated platinum surface. These results may be explained in terms of the effects of the chemisorbed oxide layer developed on the surface of passivated platinum. (auth)

21073 ON EMISSION SPECTRA OF URANYL-EDTA COMPLEXES. Sanwal, D. N.; Pant, D. D. (Government Coll., Naini Tal, India). Curr. Sci. (India), 37: 129-30(Mar. 5, 1968).

The EDTA complex with uranyl ions is strongly fluorescent. The B′ resonance band fluorescence series is due to photosensitive species that dissociate under the action of ultraviolet radiation. The B series is also photosensitive and vanishes on larger ultraviolet exposure. The B_0 band is at ~20218 cm^{-1}. (M.C.G.)

21074 GENERALIZED MEAN-SQUARE AMPLITUDES OF VIBRATION, SHRINKAGE EFFECTS, AND CORIOLIS COUPLING CONSTANTS: XY_3ZW TYPE MOLECULES. Venkateswarlu, K.; Rajalakshmi, K. V.; Purushothaman, C. (Kerala Univ., Alwaye, India). Bull. Soc. Roy. Sci. Liege, 36: 583-92(1967).

Expressions for the generalized mean-square amplitudes of vibration, which include the mean-square parallel and perpendicular amplitudes and the mean cross products, were derived in terms of the Σ-matrix elements for the XY_3ZW molecular model. Values are reported for eight molecules, CH_3CN, CD_3CN, CH_3NC, CD_3NC, $B^{10}H_3CO$, $B^{10}D_3CO$, $B^{11}H_3CO$ and $B^{11}D_3CO$. The mean-square perpendicular amplitudes were made use of in the evaluation of the shrinkage constants of the linear bonds in the above molecules. The effect of isotopic substitution on the mean-square amplitudes of vibration and the shrinkages of the bond lengths is discussed. Using the C-matrix method, the Coriolis coupling of rotation-vibration in borine carbonyl and its deuterium substituent was investigated. (auth)

21075 ISOTOPE EFFECTS IN THE ACID-CATALYZED HYDRATION OF PHENYLACETYLENE. Noyce, Donald S.; Schiavelli, Melvyn D. (Univ. of California, Berkeley). J. Amer. Chem. Soc., 90: 1023-6(Feb. 14, 1968).

The rate of the acid-catalyzed hydration of phenylacetylene, (ethynylbenzene), and of four substituted phenylacetylenes, was less in deuterated media, k_{H_2O}/k_{D_2O} being about 2. This result is in accord with a rate-limiting proton transfer. The rate of hydration of ethynyl-d-benzene was decreased by 10% by a combination of secondary isotope effects. The relation of these results to mechanism and to other related reactions is discussed. (auth)

21076 RATE CONSTANTS FOR THE SELF-REACTIONS OF N- AND SEC-BUTYLPEROXY RADICALS AND CYCLOHEXYLPEROXY RADICALS. THE DEUTERIUM ISOTOPE EFFECT IN THE TERMINATION OF SECONDARY PEROXY RADICALS. Howard, J. A.; Ingold, K. U. (National Research Council, Ottawa). J. Amer. Chem. Soc., 90: 1058-9(Feb. 14, 1968).

Rate constants for the self-reaction of saturated peroxy radicals derived from n- and sec-butyl hydroperoxide and cyclohexyl hydroperoxide were obtained by the rotating sector method using tetralin and α-methylstyrene as the oxidation substrates. The rate constants for the self-reactions of the saturated peroxy were significantly smaller than for the unsaturated radicals. Isotope effects were studied in reactions involving diphenylmethyl hydroperoxide and sec-butyl hydroperoxide. The average isotope effect, $(k)_H/(k)_D = 1.37 \pm 0.14$. It was concluded that the α-hydrogen was transferred in the rate-determining step of chain termination. (J.G.B.)

21077 REACTIONS OF COORDINATED LIGANDS. SOME STUDIES ON BIS-SALICYLIDENEAMINE CHELATES OF COPPER AND NICKEL. Auld, G. A.; Davison, A. (Massachusetts Inst. of Tech., Cambridge). Inorg. Chem., 7: 306-9(Feb. 1968).

Transesterification studies on bis[N-(alkoxycarbonylalkyl) salicylideneaminato]metal complexes, particularly those where alkoxy = t-butoxy, indicate that a dissociative mechanism with subsequent activation of the carbonyl group of the coordinated ligand is the preferred mechanism for the rapid ester exchange. A new reaction for coordinated ligands in this general class is reported, namely, the rapid transesterification of bis[N-(alkoxyglycylcarbonylmethyl)salicylideneaminato]-metal(II) complexes. Support for the proposed mechanism comes from the isolation of the tetradentate complexes ammonium N-(glycylatocarbonylmethyl)salicylideneaminatometalate(II) (M = Ni and Cu). Deuterium-exchange studies showed that the rapid racemization of bis[N-(alkoxycarbonylalkyl)salicylideneaminato]metal(II) complexes is due to a unique proton exchange at the α position via a short-lived carbanion intermediate. (auth)

21078 VOLATILITY PROCESSES. Barghusen, J. J. Reactor Fuel-Process. Technol., 10: 309-13(Fall 1967).

Experiments dealing with the fluorination of uranium oxide fuels with ClF_3 and ClF are reviewed. Studies on the sorption behavior of technetium and molybdenum fluorides on MgF_2 and NaF and studies on the chemistry of neptunium hexafluoride are reported. The fluid-bed fluorination of UO_2-PuO_2 fuel with BrF_5 is described. An experimental program which seeks to determine the processing conditions and equipment requirements for optimum batch oxidation of UO_2 is reported. Various studies on the preparation and properties of metal fluorides are reviewed. (J.G.B.)

21079 MATRIX-ISOLATION STUDY OF THE HYDROGEN CYANIDE DIMER. King, Charles M.; Nixon Eugene R. (Univ. of Pennsylvania, Philadelphia). J. Chem. Phys., 48: 1685-95 (Feb. 15, 1968).

On the basis of the infrared spectra of HCN and DCN in Ar, N_2, and CO matrices at temperatures from 4.5 to 20.5°K, it was concluded that there was no evidence for rotation of the monomeric

species in these matrices and that the dimer has a linear or nearly linear HCN·HCN structure. The Lippincott-type potential was used to calculate frequencies for the stretching of the hydrogen bond and for the torsion about the hydrogen bond. These calculated frequencies were compared with observed far-infrared spectra of dimers in the matrix and with available Raman data on crystalline HCN and DCN. (auth)

21080 ABSORPTION AND EMISSION SPECTRA OF OH AND OD IN SOLID Ne. EVIDENCE FOR ROTATION. Tinti, D. S. (California Inst. of Tech., Pasadena). J. Chem. Phys., 48: 1459-64(Feb. 15, 1968).

The $A\,^3\Sigma^+ - X\,^2\Pi_i$ system of OH and OD was studied in solid Ne at 4.2°K. Both absorption and emission spectra were recorded, the latter for the first time for OH or OD in a solid matrix. Emission was seen from $v' > 0$, establishing a relatively slow vibrational relaxation rate in the $A\,^3\Sigma^+$ state for OH and OD in solid Ne. Considerable fine structure was seen, which differed for the isotopes and was not a mirror image in absorption and emission. This structure bore no resemblance to the structure previously observed for OH and OD in the other rare gases. The observed structure in solid Ne can be partly interpreted in terms of slightly perturbed rotational motion in the solid. The larger perturbation for OH compared with OD suggests that translation-rotation coupling may be important. Rotational relaxation times shorter than 10^{-8} sec were established from the lack of rotational "hot-band" structure in the emission spectrum. (auth)

21081 INFRARED SPECTRUM OF THE MATRIX-ISOLATED OH RADICAL. Acquista, Nicolo; Schoen, Louis J.; Lide, David R. Jr. (National Bureau of Standards, Washington, D. C.). J. Chem. Phys., 48: 1534-6(Feb. 15, 1968).

Infrared absorption in the region of 3450 cm^{-1} was observed in water-rare gas matrices subjected to vacuum-ultraviolet photolysis at 20.4 and 4.2°K. The splittings and isotope frequency ratios obtained from $H_2{}^{16}O-D_2{}^{16}O$, $H_2{}^{16}O-H_2{}^{18}O$, and $D_2{}^{16}O-D_2{}^{18}O$ mixtures led to the assignment of these spectra to trapped OH radicals. No evidence for rotational motion of OH is found in these experiments. (auth)

21082 REDUCTION OF THE ISOTOPE EFFECT IN DIFFUSION OF HYDROGEN IN NICKEL AT LOW TEMPERATURES. Ebisuzaki, Y.; O'Keeffe, M. (Arizona State Univ., Tempe). J. Chem. Phys., 48: 1867-8(Feb. 15, 1968).

By using the time-lag technique and a nickel single crystal it was possible to make reliable measurements in the region of 360°K. There was a very dramatic reduction of the isotope effect as the temperature was lowered. (M.C.G.)

21083 PRODUCTION OF INORGANIC SELF-LUMINESCENT PHOSPOR MATERIALS. (to NRA, Inc.). British Patent 1,105,576. Mar. 6, 1968. Priority date June 10, 1964, United States.

A process for producing an inorganic self-luminescent phosphor material comprises heating an inorganic phosphor material above the ionization temperature, intimately mixing the phosphor vapor with tritium gas at a temperature above the vaporization temperature, and condensing the resultant mixture. ZnS is a suitable phosphor material; and after mixing with tritium, the condensation can be carried out directly on a surface to be made light-producing. (B.L.M.)

21084 METHOD FOR PRODUCING A RADIOLUMINESCENCE BODY EMITTING A WHITE (REFLECTED-) LIGHT. Murayama, Yoshihiko (to Nemoto Tokushu Kagaku Co., Ltd.). Japanese Patent 1967-7604. Mar. 28, 1967. Filed Aug. 30, 1963.

The addition of a β emitter to a zinc silicate fluorescent-substance, which luminesces by β excitation, and then treating it appropriately, produces a radioluminescence body that emits a white light in a stable and safe manner. An insoluble layer of Pm salt is uniformly formed on the surface of fluorescent substance, by adding a soluble Pm salt to the zinc silicate fluorescent-substance, which is clad with an alkali silicate. Then a film of silicon resin is further formed on its surface. (NSA of Japan)

21085 APPARATUS FOR REACTING UF_4. Kamiya, Kunio (to Hitachi Ltd.). Japanese Patent 1967-13808. Aug. 7, 1967. Filed Aug. 3, 1963.

In the proposed apparatus for reacting UF_4, a reaction vessel and a gas absorbing device are placed in a bath with a temperature control. A UF_6 bomb, located at a level lower than the bath, is connected to the two by a pipe; and a pipe connects the two to a device for clarifying the exhaust gas. A device for circulating a liquid through the bath is installed to the bath. All the devices, vessel, etc. except the clarifying and the circulating device, are enclosed in a gas-tight shield. The reaction vessel, gas absorbing device, part of the piping, etc., are under water in the bath. (NSA of Japan)

21086 AQUASOLS OF URANIUM TRIOXIDE OR URANIUM TRIOXIDE AND ZIRCONIUM DIOXIDE. (to W. R. Grace and Co.). British Patent 1,102,913. Feb. 14, 1968. Priority date Sept. 23, 1964, United States.

In a process for the preparation of an aquasol of UO_3 and ZrO_2, the cations from a dispersion in water of an alkaline precipitated diuranate/zirconia coprecipitate are replaced by H^+, and the dispersion is subsequently or simultaneously heated to 60 to 150°C until peptization occurs. The amount of diuranate/zirconia precipitate in the dispersion is such that the aquasol produced contains 1 to 12 wt % of solids. The coprecipitate is prepared by alkaline precipitation of a solution of a uranyl salt and a zirconyl salt. (B.L.M.)

21087 METHOD FOR PRODUCING A COMPLEX SALT OF PROTOPORPHYRIN WITH RADIOACTIVE IONS. Watanabe, Ryozo (to Blood Plasma Corp. of Japan). Japanese Patent 1967-8629. Apr. 18, 1967. Filed July 3, 1964.

A method is proposed for the production of protoporphyrin, radioactive-iron complex salt at a high yield using easily available materials. A mixture of an acetic acid solution of an inorganic radioactive-iron salt, and an acetic acid solution of a protoporphyrin, sodium salt, are reacted in a hot bath, in the presence, or absence, of a reducing agent, while N_2 is passed through it. After reaction ceases, air is run through to complete the reaction. Finally, nonreacted products are removed from the reacted product by using HCl and ethyl acetate. (NSA of Japan)

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Refer also to abstracts 21842, 22200, and 22208.

21088 (BMI-1829) STUDIES OF METHYL IODIDE FORMATION UNDER NUCLEAR-REACTOR-ACCIDENT CONDITIONS. Final Report. Barnes, Russell H.; McFarling, James L.; Kircher, John F.; Townley, Charles W. (Battelle Memorial Inst., Columbus, Ohio). Feb. 22, 1968. Contract W-7405-eng-92; Subcontract No. 2505. 50p. Dep. CFSTI.

For Oak Ridge National Lab., Tenn.

Chemical-kinetic calculations of factors affecting CH_3I formation were studied. The earlier model was expanded to include the effect of an additional CH_3I formation-dissociation path and of the presence of inert species which aid iodine dissociation by energetic collision. Calculations are reported for reactions at 800 and 1000°C and compared to earlier calculations. The expanded model seems to reach equilibrium faster and apparently does so without the intermediate concentrations of CH_3I in excess of equilibrium which appeared in earlier calculations. Experimentally, CH_4-iodine mixtures of 10 : 1 to 490 : 1 moles CH_4 : mole iodine were irradiated in the ^{60}Co Gamma Facility. The irradiations were conducted at temperatures from 100 to 500°C with and without steam or steam and air present. From 100 to 175°C, the reaction was independent of temperature. From 275 to 350°C, the radiation and thermal reactions appeared to combine to produce a synergistic effect. Above 350°C the thermal reaction dominated. The presence of steam enhanced CH_3I formation somewhat. The results indicate that iodine conversion to CH_3I can be significant under postulated nuclear-reactor-accident conditions at temperatures at which the thermal reaction is negligible. The radioinduced decomposition of CH_3I at 140°C was also studied experimentally, with and without the presence of steam. Steam reduced the maximum dissociation obtained from nearly 6% to slightly less than 4%. (auth)

21089 (BNL-12219) RADIATION INDUCED DECOMPOSITION OF METHYL IODIDE IN AIR. Tang, I. N.; Castleman, A. W. Jr. (Brookhaven National Lab., Upton, N. Y.). Jan. 1968. 6p. (CONF-680601-2). Dep.

For Presentation at 14th Annual Meeting of the American Nuclear Society, Toronto, Ontario.

Results of a study on the ^{60}Co γ-induced decomposition of iodomethane in air are presented. Experiments were performed at ambient temperature with mixtures of air and CH_3I of initial concentrations ranging from 1.1×10^{-8} to 2.4×10^{-4} M at dose rates varying from 4.81×10^{14} to 1.84×10^{18} eV/g-sec. The decomposition of CH_3I in the initial concentration range of 10^{-8} to 10^{-6} M was pseudo-first order since a plot of the data on semilogarithmic coordinates yielded a straight line. The total absorbed dose at 50% decomposition was 7.3×10^{18} eV/g air. Methyl nitrate and methyl nitrite were the major radiolysis products observed. A mechanism to account for the experimental observations is proposed. (D.H.M.)

21090 (DP-1109) CURIUM PROCESS DEVELOPMENT, II-1. SEPARATION OF AMERICIUM FROM CURIUM BY PRECIPITATION OF $K_3AmO_2(CO_3)_2$. Burney, G. A. (Du Pont de

Nemours (E. I.) and Co., Aiken, S. C. Savannah River Lab.). Feb. 1968. Contract AT(07-2)-1. 20p. Dep. CFSTI.

A chemical process was developed for the separation of ^{243}Am from ^{244}Cm for use in the production of kilogram quantities of ^{244}Cm. Americium was oxidized to AmO_2^+ ion in concentrated potassium carbonate solution, and $K_3AmO_2(CO_3)_2$ was precipitated. A study of the variables affecting the separation is reported. (auth)

21091 (JLI-3655) RADIATION CHEMICAL REACTIONS OF OLEFINS WITH METHANETHIOL AND WITH METHYLSILANES AND OF DIMETHYLAMINE. Final Report. Howard, B. Y.; Koski, W. S. (Johnston Labs., Inc., Baltimore, Md.). [1967]. Contract AT(30-1)-3655. 91p. Dep. CFSTI.

The effects of β- and γ-irradiation on several chemical systems were examined. Mixtures of ethylene with methylsilane and with dimethylsilane were irradiated and the G values of the 1:1 and 1:2 telomers determined. Other silane systems studied more briefly were methylsilane and methane, methylsilane alone, methylsilane and water, methylsilane and ammonia, dimethylsilane and dimethylamine, dimethylsilane and isobutylene, and ethylene and methyl- and dimethylchlorosilane. Pure dimethylamine was irradiated and the largest product was N,N,N,N-tetramethylmethylenediamine with G values of 2.5 when oxygen was excluded from the reaction. The G value was independent of temperature, dose rate, and pressure. The reaction was catalyzed by fresh metallic surfaces and small amounts of oxygen and was not affected by small amounts of NO. The proposed mechanism is an ion-molecule reaction. Studies were done on the effects of other methylamines and ammonia on the reaction, as well as 1,3,5-trimethylhexahydro-sym-triazine and various potentially catalytic surfaces. Methanol and ethylene were irradiated in the gas phase at temperatures from 150 to 285°C and pressures from 27 to 33 atmospheres. The only products found were those of the irradiation of ethylene alone. It was concluded that higher temperatures and pressures would probably have to be used in order to obtain the desired higher alcohol and ether products. Methanethiol and ethylene were irradiated in the gas phase. The major product is methylethyl sulfide, the 1:1 telomer. The G value of the product varies inversely with the temperature, directly with the pressure, directly with the ethylene and methanethiol concentrations and inversely with the dose rate. Small percentages of the free radical scavengers, NO and O_2, prevent the reaction, which is thus assumed to be a free radical reaction. A mechanism for the reaction is proposed and discussed in the light of the experimental results. The reactions of methanethiol with propylene, cis-butene-2, trans-butene-2, isobutylene, 1-butene, cyclopentene and cyclohexene were also studied. (auth)

21092 (ORO-1797-11) RESEARCH IN NUCLEAR CHEMISTRY. Progress Report, July 1, 1967-May 31, 1968. Choppin, Gregory R. (Florida State Univ., Tallahassee. Dept. of Chemistry). Feb. 28, 1968. Contract AT(40-1)-1797. 172p. DTIE.

Separate abstracts were prepared for the two sections of the report. (D.C.W.)

For abstracts of individual sections see: 21054 and 22588.

21093 (TID-24147) SUMMARY OF PROGRESS [ON PHYSICAL CHEMISTRY], NOVEMBER 15, 1966-NOVEMBER 15, 1967. [Shields, Howard W.; Hamrick, Phillip J. Jr.] (Wake Forest Univ., Winston-Salem, N. C.). Contract AT(40-1)-2835. 6p. Dep. CFSTI.

A study of a $-\dot{N}-H$ type radical in irradiated semicarbazide is reported. An attempt to study a $-\dot{N}-H$ type radical in nitrourea was unsuccessful since it was impossible to grow single crystals of nitrourea. The hydrogen-deuterium exchange in α-ureidopropionic acid was studied. After x-irradiation of α-ureidopropionic acid at room temperature the α-propionyl radical was found. When the radicals were formed in deuterated crystals, the observed spectra changed as the crystal was heated. After several hours of heating, equilibrium was reached, and 80% of the radicals contained deuterium in the α-position. An activation energy of 13 kcal/mole was found for the exchange of hydrogen with a neighboring deuterium. Free radicals of the type $R_2\dot{C}CONH_2$ were identified in X-irradiated single crystals of propionamide, n-butyramide, and isobutyramide. Principal values of the hyperfine coupling constants and their direction cosines with respect to the assigned axes were determined. (D.H.M.)

21094 MODIFICATION OF SYNTHETIC FIBER BY THE GRAFT COPOLYMERIZATION OF REACTIVE MONOMER. I. GRAFT COPOLYMERIZATION OF ACRYLIC ACID ON TO POLYPROPYLENE FIBER. Tsuji, Waichiro; Ikeda, Tetsuo (Kyoto Univ.). Sen'i Gakkaishi, 23: 327-34(July 1967). (In Jspanese).

Acrylic acid was graft copolymerized onto polypropylene fiber and fabric using ^{60}Co γ preirradiation method. As the grafted polypropylene has reactive groups such as caroboxyl groups in the grafted side chains, some aftertreatments including crosslinking can be achieved using these reactive groups. Some properties of the acrylic acid grafted and aftertreated polypropylene fiber and fabric were examined. Tensile properties such as dry, wet, and knot tenacity and elongation of the grafted and aftertreated fibers were equal to that of original polypropylene fiber. Heat shrinkage of the fibers decreased considerably by acrylic acid grafting and the fiber grafted by 62% showed heat shrinkage of 5 to 7% and melted at 300°C. The effects of aftertreatment of the grafted fiber on the heat shrinkage were also remarkable. For example, greater heat stability was obtained by Ca-salt, NH_4Cl, and epoxy treatments. Melting temperature of the polypropylene monofilament was not improved by acrylic acid grafting, but elevated to as high as above 300°C by the aftertreatment with inorganic salts of some metals such as Na and Ca. Tensile properties of the grafted and aftertreated fibers at elevated temperature did not improve as expected from the melting property. Moisture regain of polypropylene fabric increased by acrylic acid grafting and metal salt treatments. In the case of Na-salt treatment the moisture regain was about 10% in the 35.8% grafted sample. It was found that the polypropylene fabric that was 20.5% grafted with acrylic acid and converted into Na-salt had excellent dyeability for cationic dye and heat settability. Frictional static electricity of the acrylic acid grafted polypropylene monofilament and fabric decreased to about one-half of the original polypropylenes. A decrease in frictional static electricity was noted after conversion of the grafted acrylic acid to a hydrophilic Na-salt. (NSA of Japan)

21095 RADIOINDUCED ADDITION REACTIONS OF ETHERS AND ALCOHOLS TO PERFLUOROPROPENE. Muramatsu, Hiroshige; Inukai, Kan (Government Industrial Research Inst., Nagoya, Japan). Nagoya Kogyo Gijutsu Shikensho Hokoku, 16: 319-25(Oct. 1967). (In Japanese).

The radioinduced addition reactions of ethers and alcohols to perfluoropropene were studied. Mainly the 1:1 adducts were obtained in excellent yields, but in the addition of diethyl ether and dioxane the 1:2 adduct with a symmetrical structure was produced along with the 1:1 adduct. The ethers containing the perfluoropenyl group were prepared by the dehydrofluorination of the corresponding 1:1 adducts. From the proton and fluorine NMR spectra, the attacks of the α-ethereal and α-hydroxyalkyl radicals were found to occur exclusively on the difluoromethylene carbon. The relative reactivities of ethers and alcohols were determined by the competitive reaction. (NSA of Japan)

21096 RADIATION-INDUCED GRAFT COPOLYMERIZATION OF STYRENE TO POLYETHYLENE SINGLE CRYSTAL AGGREGATE FILM. Takamatsu, Toshiaki; Konaga, Toshiyoshi. Kobunshi Kagaku, 24: 795-800(Dec. 1967). (In Japanese).

The radioinduced graft polymerization of styrene onto the polyethylene single crystal aggregate films, which were crystallized and annealed at various temperatures, was carried out. The long period and density of the film increased with the increase of crystallization and annealing temperatures. Correspondingly, the grafting efficiency decreased with the increase of crystallization and annealing temperatures. The equilibrium absorption of styrene in the film increased with the increase of crystallization temperature, which seemed to indicate the rough overlap of lamella surfaces at higher crystallization temperature. It decreased, however, with the increase of annealing temperature which caused the thickening of lamellae. It was concluded that the graft polymerization is mainly produced at the surface of the lamellar crystals. (NSA of Japan)

21097 RADIATION EFFECTS ON GLASS CONTAINING CERIUM. Nonomura, Takuo; Yamamoto, Kakuji (Tokyo Metropolitan Inst. for Radiological Research). Oyo Butsuri, 37: 54-9(Jan. 1968). (In Japanese).

In order to elucidate the mechanism of the gamma radioinduced electrical breakdown of shielding window glass, electrical conductivity and thermally released current in various glasses irradiated as a function of temperature under the condition of temperature-gradient were studied. The electric conductivity curve of the irradiated cerium glass showed a positive maximum or a negative minimum at 55°C, according to whether the directions of electric field and irradiation are the same or reverse. If the directions of temperature gradient and irradiation were the same, the thermally released current showed a positive maximum at 55°C but if reversed, it showed a negative minimum at 55°C and a positive maximum at 75°C. When the samples were irradiated under the rotation, no maxima and minima were observed. It is suggested that the maxima and minima at 55°C are based on the thermal release of trapped electrons which entered from the atmosphere into the sample by Compton recoils. The maxima and minima at 75°C imply the thermal release of trapped electrons which are generated within the sample by Compton recoils. The maxima and minima

were also observed in the samples containing titanium or vanadium instead of cerium. (NSA of Japan)

21098 SPECTROSCOPIC ANALYSIS OF RADIATION PROCESSES IN RUBBER AT LOW TEMPERATURES. Sukhov, F. F.; Il'icheva, Z. F.; Slovokhotova, N. A.; Margolin, D. M.; Terekhov, V. D. (Inst. of Physical Chemistry, Moscow). Khim. Vys. Energ., No. 1, 58-64(1967). (In Russian).

A method for distinguishing between the changes in polymer structure due to primary and secondary radiochemical processes during low-temperature radiolysis of polymers (primary processes) and their heating (secondary processes) is described. This method is based on measurements of ir spectra of specimens in vacuum within a special cuvette, with attendant recording of changes in molecular structure due to primary processes. With the aid of this method the effects of fast electrons on the structure of guttapercha, natural cis-polybutadiene rubber, and polychloroprene rubber were investigated at 120°K. The structural changes observed in these types of rubber according to their spectra indicate that low-temperature radiolysis is accompanied by processes of cross-linking, isomerization, and migration of double bonds, amorphization, and the detachment of low-molecular products. Thus it was established that even at low temperatures, during irradiation, the unsaturation predominating in the rubber begins to disappear, trans-vinylene double bonds arise, the degree of crystallinity decreases, and in the irradiation of polychloroprene rubber the HCl splits off. The occurrence of secondary reactions was traced according to variation in the structure of the irradiated varieties of rubber following their subsequent heating. (JPRS)

21099 STUDIES ON FREE RADICALS PRODUCED BY IRRADIATION. 6. ELECTRON SPIN RESONANCE OF PEROXY RADICALS PRODUCED IN TETRAFLUOROETHYLENE–HEXAFLUOROPROPYLENE COPOLYMERS. Iwasaki, Machio; Inoue, Michiko (Government Industrial Research Inst., Nagoya, Japan). Nagoya Kogyo Gijutsu Shikensho Hokoku, 16: 336-41(Oct. 1967). (In Japanese).

Copolymers of tetrafluoroethylene and hexafluoropropylene gave free radicals showing an almost symmetric ESR spectrum with a large g-value, when air was introduced after irradiation in vacuo or when irradiated in air. When measurements were made at 77°K, this spectrum changed into the asymmetric line shape which is characteristic of the axially symmetric g-tensor. The temperature change of the spectral line shape, which was found to be reversible, and the spectral change caused by the thermal annealing suggest that this spectrum is attributed to a peroxy radical produced by the reaction of oxygen with the tertiary carbon radicals which are the predominant radicals when irradiated in vacuo. This radical gave the symmetric line shape because the complete averaging of the g-anisotropy caused by the motion of the trapped radicals in a region where the regular crystallization was perturbed by CF_3 groups. The asymmetric spectrum similar to that of polytetrafluoroethylene was also found as a minor component of the spectrum. (NSA of Japan)

21100 STUDIES ON FREE RADICALS PRODUCED BY IRRADIATION. V. ELECTRON SPIN RESONANCE OF TETRAFLUOROETHYLENE–HEXAFLUOROPROPYLENE COPOLYMERS γ IRRADIATED IN VACUO. Iwasaki, Machio; Toriyama, Kazumi (Government Industrial Research Inst., Nagoya, Japan). Nagoya Gijutsu Shikensho Kokoku, 16: 292-300(Sept. 1967). (In Japanese).

Radicals produced in tetrafluoroethylene–hexafluoropropylene copolymers γ-irradiated at room temperature in vacuo were studied by electron spin resonance. Besides the well-known spectra assigned to the radicals ... $CF_2-CF-CF_2$ ... and ... $CF_2-CF_2-O\cdot$, a poorly resolved eight-line spectrum was found and tentatively assigned to the tertiary carbon radical ... $CF_2-C(CF_3)-CF_2$ .... Upon heating, this radical disappeared much faster than the others. This is probably because it is trapped in a region where the regular crystallization of the copolymer chains was perturbed by trifluoromethyl groups. The temperature and orientation dependence of the spectra were also examined and interpreted in terms of the proposed radical. (NSA of Japan)

21101 RADIATION-INDUCED VULCANIZATION WITH 20 TO 30-MeV ELECTRONS. Kim, I. P.; Egorov, E. V.; Gol'danskii, V. I.; Dogadkin, B. A.; Tarasova, Z. N. (Moscow Inst. of Fine Chemical Tech.). Kauchuk Rezina, No. 12, 15-18(1966). (In Russian).

The radioactivity of rubbers, rubber mixtures, and their ingredients irradiated with 20 to 30 MeV electrons was investigated. The study was undertaken because 5 to 10 MeV electrons, currently used in radioinduced vulcanization, penetrate only to a small depth (2 to 4 cm in a substance with a density of 1 g/cm³) and, therefore, are unsuitable for the vulcanization of large-size products. Theoretical analysis of the problem and experiments showed that the reactions proceeded under the effect of electromagnetic radiation generated as a result of deceleration of fast electrons in the substance. Irradiation of rubbers, rubber mixtures, and their ingredients with fast, 20 to 30 MeV electrons formed the radioactive isotopes ^{11}C, ^{15}O, and ^{65}Zn as a result of γ, n-type photonuclear reactions. Due to the short halflife (minutes or tens of minutes) of these isotopes, the radioactivity that was induced in the irradiated specimens decayed in a matter of hours. Rubbers, rubber mixtures, and their ingredients were not activated with secondary neutrons. The use of fast, 20 to 30 MeV electrons for the vulcanization of large-size rubber products presented no danger for personnel, provided that the irradiated products were held in isolation for one day. (ATD)

21102 ELECTRON SPIN RESONANCE STUDIES OF RADIATION DAMAGE. PART I. AN ALTERNATING LINE-WIDTH EFFECT FOR THE $(CH_3)_2COH$ RADICAL IN GAMMA-IRRADIATED ACETONE AT LOW TEMPERATURES. Sargent, F. P. (Univ. of Saskatchewan, Saskatoon). Can. J. Chem., 46: 1029-31(Mar. 15, 1968).

The ESR spectrum of the $(CH_3)_3COH$ radical showed a drastic temperature dependence of linewidth in the range −196 to −100°C, this being particularly pronounced for the $M_I = \pm 2$ lines. Possible mechanisms are discussed in terms of restricted rotation of the methyl groups and of the OH groups. (auth) (UK)

21103 RADIOLYSIS OF LIQUID PROPANE: NON-RADICAL REACTIONS. Koob, R. D.; Kevan, Larry (Univ. of Kansas, Lawrence). Trans. Faraday Soc., 64: 706(Mar. 1968).

The yields of ionic and excited molecule reactions in the γ-radiolysis of liquid propane from 35 to −130°C were assessed by isotopic analysis of $C_3H_8 + C_3D_8 + O_2$ and $CH_3CD_3CH_3 + O_2$ mixtures. From a comparison with gas phase data the following conclusions are reached for the gas to liquid phase change: the ionic decomposition yield decreases by ≈69%; the net excited molecule decomposition yield decreases by 7% or less; parent ion fragmentation still occurs in the liquid and exhibits fragmentation processes requiring 1-4 eV excitations; the H_2^-/H^- transfer reaction ratio for $C_3H_7^+ + C_3H_8$ seems to be increased; and the isotopic decomposition of $CH_3CD_2CH_3$ is drastically changed. (auth) (UK)

21104 MODIFICATION OF SYNTHETIC FIBER BY THE GRAFT COPOLYMERIZATION OF REACTIVE MONOMER. II. GRAFT COPOLYMERIZATION OF ACRYLIC ACID ONTO POLYVINYL CHLORIDE FIBER. Tsuji, Waichiro; Ikeda, Tetsuo (Kyoto Univ.). Sen'i Gakkaishi, 23: 335-41(July 1967). (In Japanese).

Acrylic acid was graft copolymerized onto polyvinyl chloride (PVC) multifilament yarn using ^{60}Co γ irradiation and some properties of the fibers were examined. Tensile properties of fibers such as dry and wet tenacity and elongation were almost unchanged by the grafting or aftertreatment. Heat shrinkage of the PVC fibers was decreased by acrylic acid grafting. The original PVC fiber showed the heat shrinkage up to about 60% of its original length, while that of the 60.5% grafted PVC fiber was below 10%. The effects of aftertreatments of the grafted fibers on the heat shrinkage were remarkable. About 25% grafted PVC fiber aftertreated with $Ca(CH_3COO)_2$ showed heat shrinkage of only 10% or below under 300°C. Tensile properties of the grafted and aftertreated PVC fibers were not improved at higher temperature in spite of their excellent heat stability. (NSA of Japan)

21105 RADIOINDUCED POLYMERIZATION REACTION OF ETHYLENE. Kawakami, Waichiro; Machi, Sueo (Japan Atomic Energy Research Inst., Tokyo). Kagaku Kogaku, 12: 1-9(June 1967). (In Japanese).

The radioinduced polymerization of ethylene is described for the batch reactions in an autoclave and for reactions in an apparatus of the gas-flow type. The results of kinetic studies for the former are expressed as $R = k_1 f_M^{\alpha} \rho_M^{\beta} t$ and $\bar{P}_n = k_2 f_M^{\gamma} t$, where R is the polymerization velocity, f_M is the fugacity of ethylene, ρ_M is the density of ethylene, t is the reaction time, $\bar{P}_n$ is the average degree of polymerization, and k_1 and k_2 are constants. Assuming the presence of long-lived free radicals, the two-step radiation polymerization method was developed, in which the monomer was first irradiated with a high dose rate, e.g., 2.5×10^4 RAD/hr, then, with a very low dose rate, e.g., 300 RAD/hr. The polymerization velocity in the second step was proportional to the total radiation dose in the first step. It was concluded that the addition of molecules of ethylene monomer to the growing chain radicals took place as an excited dimer (excimer), which was produced by the overlapping of the π electron orbitals of ethylene molecules in the excited and in the ground state. The stirring of the polymerization system was found to lower the polymer yield and the polymerization degree of the polymer. The effects of the flow rate of ethylene on the reactions in the gas-flow type apparatus were studied kinetically. (NSA of Japan)

21106 RADIOLYSIS OF LIQUID BRANCHED ALKANES. Kudo, Tomoyoshi (Tokyo Inst. of Tech.). Tokyo Kogyo Daigaku Gakuho, No. 76, 9-13(Mar. 1966).

Results of studies on the radiolysis of several branched alkanes in the liquid phase are summarized, with emphasis on: the precursors of the products and their behavior; the characters of intermediates such as H atoms, free radicals, and fragment ions, and the processes of their arriving at the final products; the C–H and the C–C bond ruptures in the molecules or molecular ions; and the excitation and charge-transfer processes from excited species to other molecules. The C–C bond rupture reactions in the liquid-phase radiolysis of 2,2,4- and 2,3,4-trimethylpentanes are described. Considering the scavenging reactions by iodine the apparent G values are given for some scission reactions of the alkanes. The radiolysis of binary mixture systems of liquid alkanes is also described, particularly for the combination of cyclopentane and 2,2,4-trimethylpentane, and of cyclopentane and n-hexane. (NSA of Japan)

21107 FREEZING OF PHOTOELASTICITY FRINGES BY GAMMA-RAY IRRADIATION. I. ON THE PHENOMENON OF THE REMAINING PHOTOELASTICITY FRINGES. Miyazono, Shohachiro; Sakamoto, Fumio (Japan Atomic Energy Research Inst., Tokyo). Nippon Kikai Gakkai Rombunshu, 33: 1169-74 (Aug. 1967). (In Japanese).

Irradiation by γ rays of molded samples of a mixture of epoxy resin and a hardening agent resulted in freezing of the photoelasticity fringes. The samples were irradiated under load. If the photoelasticity fringes produced before irradiation under load remain 100%, a dosage of about 2.0×10^8 R is required. To achieve this, a long period of irradiation is necessary, which gives rise to the problem of the resin being subjected to the photo-plasticity effect due to the optic creep. Compared with the conventional freezing phenomena, the recovery of photoelasticity fringes after freezing is somewhat rapid, and so it is necessary to know in advance the amount of recovery for a period after the load removal. Care is necessary in the preparation of the test specimens since the amount of hardener added is small. If the radiation dose is large, the specimen is discolored but for a thickness of 6 to 10 mm their photography is not affected. (NSA of Japan) (TSS)

21108 RADIATION POLYMERIZATION OF VINYL ETHER. Naruse, Tsutomu; Fueki, Kenji (Nagoya Univ., Japan). Kogyo Kagaku Zasshi, 70: 580-3(Apr. 1967). (In Japanese).

In order to clarify the mechanism of radiation polymerization of vinyl ether, various vinyl ethers were studied. The polymerization was carried out at 25°C for the ordinary dehydrated and the completely dehydrated systems. In the ordinary dehydrated system, the polymerization velocity was little influenced by an ion-take-up agent such as NH_3, but was remarkably reduced by a radical inhibitor. This gave evidence for the radical mechanism. For the completely dehydrated system, n-butylvinyl ether was studied. The G(–M) was about 25 times larger than that of the ordinary dehydrated system, showing a remarkable increase in the polymerization velocity. Addition of low concentration of NH_3 or CH_3OH inhibited the polymerization considerably. These results indicated a cation mechanism by a free ion. From the results of the NH_3-added system, $k_p = 8.4 \times 10^7$ M^{-1} sec^{-1} was obtained as the growth-velocity constant at 25°C. (NSA of Japan)

21109 RECOIL TRITIUM EXCITATION OF MOLECULES. DIRECT EVIDENCE FOR 1,2-HX ELIMINATION FROM ETHYL FLUORIDE AND ETHYL CHLORIDE. Tang, Yi-noo; Rowland, F. S. (Univ. of California, Irvine). Contract AT(11-1)-34. J. Amer. Chem. Soc., 90: 570-3(Jan. 31, 1968).

The gas-phase elimination of HX from excited ethyl chloride and ethyl fluoride was found to proceed by a 1,2-elimination mechanism through recoil tritium experiments with the partially deuterated molecules. The ratio of C_2HD_2T to C_2H_2DT is approximately 1.9 from CD_3CH_2X and 1.45 from CH_3CD_2X for either X = F or X = Cl, reflecting a combination of isotopic and position effects in the recoil tritium substitution reactions. (auth)

21110 UNIMOLECULAR REACTIONS SUBSEQUENT TO RECOIL TRITIUM REACTIONS WITH DICHLOROMETHANE. FORMATION OF MONOCHLOROCARBENE. Tang, Yi-noo; Rowland, F. S. (Univ. of Kansas, Lawrence. Univ. of California, Irvine). Contracts AT(11-1)-407; AT(11-1)-34. J. Amer. Chem. Soc., 90: 574-82(Jan. 31, 1968).

The reactions of recoil tritium atoms with dichloromethane produced $CHTCl_2^*$ and CH_2TCl^* by substitution of T for H and T for Cl, respectively. Unimolecular decomposition of $CHTCl_2^*$ proceeded largely through elimination of hydrogen chloride, with the formation of monochlorocarbene in the singlet state. The latter was detected through its addition to ethylene to form cyclopropyl-t chloride in both the presence and absence of O_2 as scavenger. The excited CH_2TCl^* molecules decomposed by C–Cl bond breakage with no evidence for carbene formation as a competitive process. The relative yields of the primary hot reactions with CH_2Cl_2 were in the ratio HT : $CHTCl_2$: CH_2TCl = 100 : 51 ± 5 : 25 ± 2. These values were determined in scavenged liquid-phase experiments and are very different from previously measured values because of extensive unimolecular decomposition of the substitution products in the gas phase. (auth)

21111 RADIATION-INDUCED "HYDROLYSIS" OF THE PEPTIDE BOND. Rodgers, Michael, A. J.; Sokol, Harvey A.; Garrison, Warran M. (Univ. of California, Berkeley). J. Amer. Chem. Soc., 90: 795-6(Jan. 31, 1968).

The role of the reducing species, the hydrated electron (e_{aq}^-), in the chemistry of the liberation of alanine in the γ-radiolysis of an oxygen-free solution of N-acetylalanine was studied. Results indicated that reductive cleavage of the peptide bond does not yield the major portion of the observed alanine even though the formation of this product is directly related to the attack of the reducing species. It is suggested that the radical products of e_{aq}^- and OH attack are removed by disproportionation. Equations to support this theory are submitted. (J.G.B.)

21112 RATE OF RADIOLYSIS OF THE DISULPHIDIC GROUPS OF INSULIN IN AQUEOUS SOLUTIONS EXPOSED TO X-IRRADIATION. Fojtik, A.; Brdicka, R. (Inst. of Physical Chemistry, Prague). Collect. Czech. Chem. Commun., 33: 462-7(Feb. 1968).

In the previous experiments it was found that γ-irradiated aqueous solutions of insulin exposed to air gradually lose their polarographic activity. Preliminary analysis of the kinetic data showed that the rate of inactivation of disulfidic groups follows first order kinetics after a specific induction period has elapsed. Further experiments were performed in which dilute aqueous solutions of insulin were x-irradiated with different dose intensities at different initial insulin concentrations. For all the cases examined the same formal rate constant of the first order reaction was obtained ($k \sim 10^{19}$ ml eV^{-1}); it is independent of both the dose intensity and the initial insulin concentration. This finding implies that the dose necessary to reduce the activity of disulfidic groups to e^{-1} is also independent of the quantities mentioned and that the radiation yield is proportional to the initial insulin concentration. The results thus correspond to the criteria of the direct radiation effect in the inactivation of insulin disulfidic groups in the concentration range studied. (auth)

21113 THEORY OF THE RADIATION CHEMICAL YIELD. II. DERIVATION OF THE FUNDAMENTAL RELATIONS. Santar, I.; Bednar, J. (Inst. of Nuclear Research, Prague). Collect. Czech. Chem. Commun., 33: 1-17(Jan. 1968).

Attempts were made to derive an adequate physical description of primary radiation-chemical yields. Excitations and ionizations of valence electrons by electrons of the degradation spectrum represent the main processes of primary activations of molecules in the physical stage of radiolysis. Fast electrons induce optical transitions with the yield g^0, which can be expressed by Bethe-Born approximation for cross sections. The yield g^s from collisions of slow electrons can be estimated by approximate procedures only. (auth)

21114 LOCATION OF SOME TYPICAL VINYL POLYMERS WITHIN RADIATION-GRAFTED COTTON FIBERS: AN ELECTRON MICROSCOPICAL SURVEY. Rollins, M. L.; Cannizzaro, A. M.; Blouin, F. A.; Arthur, J. C. Jr. (Southern Regional Research Lab., New Orleans). J. Appl. Polymer Sci., 12: 71-105(Jan. 1968).

Electron microscopic investigations on the relationship of the structure of vinyl–cotton graft polymers to the original morphology of the cotton fiber and the distribution of the grafted vinyl polymer in the cotton fiber structure are reported. The grafted vinyl monomers studied were acrylonitrile, styrene, methyl methacrylate, and vinyl acetate. Two radioinduced procedures were used: simultaneous irradiation grafting and post-irradiation grafting. Ceric ion grafting of acrylonitrile to cotton was included for purposes of comparison. Distribution of the vinyl polymer within the cotton fiber is illustrated by a series of electron micrographs, selected as typical of the particular grafted species under consideration. Results indicate that the diffusion rate of monomer into the cellulose fiber plays an important role in the final distribution of polyacrylonitrile grafts within the fiber. Uniform distribution of polyacrylonitrile in the fiber was achieved by simultaneous irradiation grafting of acrylonitrile on a highly substituted cyanoethylated cotton. In samples of low degree of cyanoethylation the distribution of graft polymer was nonuniform. In grafting initiated by ceric ion the acrylonitrile graft polymer was evenly distributed. Polystyrene–cotton copolymers from grafts, made by simultaneous irradiation of cotton in methanol solutions of the styrene monomer, were uniform throughout the fiber but showed opening of structure associated with the amount of graft

formed. Grafting of methyl methacrylate occurred only in the peripheral regions of the fiber; by contrast, grafting of vinyl acetate was uniform throughout the fiber wall. Important factors governing the successful irradiation grafting in cotton fibers are choice of solvent, ratio of monomer to cellulose, nature of prior chemical modification of the cellulose, and total irradiation dosage. (auth)

21115 RADIATION GRAFT-COPOLYMERIZATION OF 2-VINYLPYRIDINE WITH CELLULOSE. Sadykov, M. U.; Azizov, U.; Usmanov, Kh. U.; Mirkamilov, I. M. Vysokomol. Soedin., Ser. A, 10: 322-30(Feb. 1968). (In Russian).

Vapor phase radiation graft copolymerization of 2-vinylpyridine with cellulose has been studied. 2-vinylpyridine is more easily grafted to cotton cellulose than to hydrate-cellulose. In presence of water vapor and with higher doses the yield of the graft-copolymer was highly increased. Kinetics of graft copolymerization on cotton cellulose at dose rates 10, 70, and 130 R/sec were studied. The rate was proportional to the dose rate in 0.6 power and radiation-chemical yield in 0.4 power. Infrared spectra, sorbtion of water vapor, dyeability with acid dyes, heat resistance, and mechanical properties of the graft-copoylmers obtained have been studied. (auth)

21116 THERMODYNAMIC STUDY OF SOLUBILITY OF GRAFT-COPOLYMERS OF PERCHLOROVINYL WITH VINYL-ACETATE OBTAINED BY MEANS OF RADIATION. Tashmukhamedov, S. A.; Usmanov, Kh. U.; Tillaev, R. S.; Kis'yantseva, L. L. (Tashkent State Univ.). Vysokomol. Soedin., Ser. A, 10: 379-83(Feb. 1968). (In Russian).

Dependences of integral heats of swelling, density, and infrinsic viscosity of graft-copolymers of polyperchlorovinyl with poly (vinyl acetate) on dose of radiation at synthesis have been studied. Thermodynamic functions of solvent (dichloroethane) interaction with the graft copolymer and starting polymer have been determined. (auth)

21117 RADIATION CHEMISTRY OF ISOTACTIC AND ATACTIC POLYPROPYLENE. RADIOLYSIS IN THE NITROUS OXIDE. Kondo, Mamoru (Electrical Communication Lab., Tokyo). Denki Tsushin Kenkyusho Kenkyu Jitsuyoka Hokoku, 16: 1203-10(June 1967). (In Japanese).

Polypropylene was irradiated with ^{60}Co γ rays in the presence of about 60 cm Hg N_2O. To examine the radiation effects, the product gases were analyzed and the gel percentage and intrinsic viscosity were measured. The reactions of crosslinking and breakage were compared with the case of vacuum irradiation. The G value for the evolution of H_2 and CH_4, in the presence of N_2O, decreased at the same rate as for the vacuum irradiation. The G values for the crosslinking and the breakage both increased, the rate of increase being larger for the former. The intrinsic viscosity rapidly decreased in the early stages of irradiation and the G value for the breakage (in the early stages) was much larger than the value derived from the gel percentage at the later stages. It appeared that N_2O acted possibly as an electron scavenger, and reacted with the polymer ion, promoting the formation of the polymer radical, increasing the number of bridgings, preventing the formation of H_2, and producing H_2O. The material balance was considered according to this reaction mechanism. (NSA of Japan)

21118 ELECTRON SPIN RESONANCE OF AN IRRADIATED SINGLE CRYSTAL OF GUANINE HYDROCHLORIDE DIHYDRATE. Alexander, Chester Jr.; Gordy, Walter (Duke Univ., Durham, N. C.). Proc. Nat. Acad. Sci. U. S., 58: 1279-85(Oct. 1967).

Single crystals of guanine hydrochloride dihydrate were irradiated with γ-rays from a 3-kilocurie ^{60}Co source and observed at room temperature with an ESR spectrometer. Only one type of radical was observed, but it had two distinguishably different orientations in the crystal. Three types of nuclear hyperfine structure were observed in the ESR spectra of the radical. The hydrogen addition on $C_{(8)}$ gave a methylene group with hydrogen atoms projecting above and below the plane of the molecule. The methylene hydrogen nuclei couple through the mechanism of hyperconjugation to the unpaired electron in the pi system of the molecule to give a hyperfine splitting. Another type of observed hyperfine structure was due to ^{14}N nuclear coupling. The third type of nuclear hyperfine structure resulted from the ionic form $(H\text{-guanine})^+$ of the molecules in the crystals in which the H^+ from the HCl became attached to the $N_{(7)}$ of guanine. Derivation of the principal values of the nuclear coupling and g-tensor, spin densities on the nitrogens, and proton coupling in N–H fragment are also considered. (D.H.M.)

21119 FORMATION OF XeO_3 DURING β DECAY OF ^{131}I IN SOME PERIODITE SOLUTIONS. Gusev, Yu. K.; Kirin, I. S.; Isupov, V. K. Radiokhimiya, 9: 736(1967). (In Russian).

Studies were made of chemical reactions taking place during decay of ^{131}I in oxygen-containing compounds of seven valence iodine. Emanation of elementary ^{131m}Xe was evaluated for a series of periodates. Variation of bound xenon yield were observed during ^{131}Xe concentration in crystals and during lithium periodate transition to cesium periodate. (R.V.J.)

21120 SEPARATION OF CARRIER-FREE ^{111}Ag FROM NEUTRON-IRRADIATED PALLADIUM. Abdusalyamov, N. (Inst. of Nuclear Physics, Tashkent). Izv. Akad. Nauk Uzb. SSR, Ser. Fiz.-Mat. Nauk, No. 6, 68-9(1967). (In Russian).

Studies were made of a radioisotope, $^{111}Ag(T_{\frac{1}{2}} = 7.4$ days), emitting β particles with energies of 0.69(6%), 0.79(1%), and 1.04(93%) MeV and γ rays of 0.247 and 0.340 MeV. A method was developed for separation of ^{111}Ag from neutron-irradiated palladium by carbon tetrachloride extraction of silver diethyldithiophosphate. The distribution of metallic palladium impurities (3×10^{-5}%Cu, 3.3×10^{-3}%Au, 5.2×10^{-1}%Pt, 2×10^{-3}%Ir and 2×10^{-2}%Ag) was studied in relation to the concentration of the hydrochloric acid and data on their influence in the extraction of ^{111}Ag were tabulated. (R.V.J.)

21121 PREPARATION OF PURE ^{147}Pm BY ION EXCHANGE. Mihailova, V. (Bulgarian Academy of Sciences, Sofia). Compt. Rend. Acad. Bulg. Sci., 20: 1133-5(1967).

^{147}Pm may be produced in a carrier-free state by milking from neutron (n,γ) reaction products in neodymium. Soon after irradiation neodymium should be separated from promethium and allowed to cool for 2 to 3 months to accumulate ^{147}Pm. Pure ^{147}Pm may be obtained in the second extraction. (M.C.G.)

21122 ARGON-SENSITIZED RADIOLYSIS OF METHANE AND ETHANE IN THE LIQUID PHASE. Klassen, Norman V. (Mellon Inst., Pittsburgh). J. Phys. Chem., 72: 1076-8(Mar. 1968). (RRL-2310-203).

The γ-radiolysis of argon–methane and argon–ethane solutions in the liquid phase was investigated at a dose rate of 6×10^{17} eV/g min (10^4 RADs/min). In the argon-sensitized radiolysis of liquid methane considerable sensitization occurred. It was found that $G(C_2H_6)$ and $G(C_3H_8)$ were constant at low methane concentrations. In the presence of NO, ethylene was found as a product, and ethane and propane yields were depressed. Efficient energy transfer was observed in the radiolysis of liquid argon–ethane. The G values of hydrocarbon products were essentially constant at low ethane concentrations. In the radiolysis of argon solutions containing less than 1% methane, ethane, or ethylene the initial absorption of energy in these solutions was almost entirely by argon. Yet it was obvious that, in each case, a large fraction of the absorbed energy was ultimately utilized to destroy the hydrocarbon solute. For all solutes, the G value of each product was constant over the range 1 to 0.05% solute. (D.H.M.)

21123 EFFECTS OF HIGH PRESSURE ON THE PROPERTIES OF GLASS. Tashiro, Megumi; Yamamoto, Tokuji; Sakka, Sumio (Tashiro Lab., Japan). Bull. Inst. Chem. Res., Kyoto Univ., 45: 318-32(Sept. 1967).

Glass powders of various compositions were compressed at 10 to 65 kilobars with a simple squeezer type apparatus, and after release of the pressure changes in their refractive index, light absorption spectrum and crystallization tendency on reheating were examined. On the basis of the experimental results, permanent shrinkage of glass in bulk caused by high pressure and its release on reheating, local shrinkage of glass in the neighborhood of transition elements (cobalt ions) or color centers, produced by γ-irradiation, effects of high pressure on crystallization of glass and effects of high pressure in reducing silver ions in glass were discussed. (auth)

21124 KINETIC ASPECTS OF THE RADIATION POLYMERIZATION OF VINYL MONOMERS IN SOLUTION. Vlagiu, Ion. Stud. Cercet. Chim., 14: 615-26(Sept. 1966). (In Rumanian).

Kinetic aspects of the radioinduced polymerization of various monomers are reviewed. Interaction of ionizing radiation with monomeric molecules may induce primary processes resulting in the uniform ionization or excitation of the molecules, secondary processes leading to the formation of free radicals or ions from excited molecules, and delayed processes, resulting in neutralization under formation of excited molecules. If the monomer is dissolved in a solvent, the radiation may reduce the overall reaction rate in proportion with the concentration of the monomer. Other effects include the shortening of the chain length, reduction of the mean molecular weight of the polymer, and changes in the initiation rate, caused by the radiolysis of the solvent. The effects of the temperature on these processes is clarified. The startup rate is temperature independent; the rate of propagation varies only slightly with the temperature while the termination energy of activation is very small. The overall energy of activation may be determined on the basis of

the Arrhenius law. In the case of methacrylic acid, the polymer formed may initiate a new polymerization process (post-polymerization), involving probably peroxide radicals. Twenty-two references are included. (TTT)

21125 EFFECT OF POST-IRRADIATION HEAT TREATMENT ON POLYTETRAFLUOROETHYLENE. Tutiya, Mituaki; Yamamoto, Kakuji (Tokyo Metropolitan Inst. for Radiological Research). Jap. J. Appl. Phys., 7: 440(Apr. 1968).

Polytetrafluoroethylene was gamma-irradiated at room temperature in air. The effects of post-irradiation heat treatment were studied. Variations in NMR spectra as a result of changes in post-irradiation heat treatment temperatures were examined. The width of the narrow-line component was observed to increase with the temperature. An increase in crystallinity due to post-irradiation heat treatment took place abruptly within the narrow temperature ranges of 100 to 150°C and 200 to 300°C. (J.G.B.)

21126 FREE RADICALS OF NUCLEIC-ACID COMPONENTS INDUCED BY RADIATION FROM ATOMIC REACTOR. Hase, Hirotomo; Tahira, Sadamu; Sidei, Tunahiko (Kyoto Univ.). Jap. J. Appl. Phys., 7: 427-31(Apr. 1968).

Nucleic-acid bases and pyrimidine nucleosides were irradiated at room temperature as dry powders in the pneumatic tube of an atomic reactor. The total dose was estimated as 1.8×10^7 RAD. ESR measurements were made at 77°K. With the exception of adenine the first derivative spectra obtained were similar to those already reported using γ irradiation. Radical yields of the bases correspond to the order: cytosine > adenine > uracil > thymine > guanine; in the case of pyrimidine nucleosides, cytidine > uridine > thymidine. Radical yields of the nucleosides were about ten times higher than those of the bases. (auth)

21127 EFFECT OF GAMMA IRRADIATION ON THE PHYSICOCHEMICAL PROPERTIES OF COTTONSEED OIL. Tursunov, M.; Rizaev, N. U.; Mirzakarimov, R. M.; Ibragimov, A. P.; Sukhinina, L. A. (Tashkent Polytechnical Inst., Inst. of Nuclear Physics, Tashkent). Izv. Vyssh. Ucheb. Zaved., Pishch. Tekhnol., No. 6, 31-3(1966). (In Russian).

Glass tubes containing 50 ml samples of cottonseed oil were gamma irradiated with single doses ranging from 0.5 to 100 million R (250 R/sec) and fatty acid composition, acid number, peroxide number, and color changes were determined. The acid number was determined by titration, peroxide number by infusion, and color of oil by VNIIZh-12 colorimeter. Data show that with 0.5 to 100×10^6 R doses the fatty acid composition of cottonseed oil barely changes, the peroxide number increases tenfold, and the acid number increases twofold. The color of the cottonseed oil becomes increasingly lighter with gamma doses up to 40×10^6 R, and with higher doses the color continues to become lighter, but the changes are very slight. Literature sources suggest that the color change induced by gamma irradiation can be attributed to gossypol breakdown. Tests conducted on sunseed oil showed that γ radiation acts on native and derived gossypol in the same manner. In tests on cottonseed miscella of different concentrations, it was found that color changes less with higher miscella concentrations. Also, color of the cottonseed miscella becomes lighter with irradiation doses up to 40×10^6 R, but with higher doses no further color change is observed. (ATP)

21128 ANSWER TO COMMENT ON INFLUENCE OF THE DIELECTRIC CONSTANT ON THE YIELD OF FREE IONS PRODUCED DURING RADIOLYSIS OF A LIQUID AND ON KINETICS ON POSITIVE CHARGE AND ELECTRON SCAVENGING. Freeman, G. R. (Univ. of Alberta, Edmonton). J. Chem. Phys., 48: 1877-8(Feb. 15, 1968).

21129 NANOSECOND PULSE RADIOLYSIS STUDIES OF THE REACTION OF IONS IN CYCLOHEXANE SOLUTIONS. Thomas, J. K.; Johnson, K.; Klippert, T.; Lowers, R. (Argonne National Lab., Ill.). J. Chem. Phys., 48: 1608-12(Feb. 15, 1968).

The positive and negative ions of biphenyl and anthracene were observed in the pulse radiolysis of solutions of these molecules in deaerated cyclohexane. Most of the ions ($G \sim 0.9$) decayed rapidly over 50 nsec, while a small yield ($G \sim 0.2$) decayed over many microseconds. The rapid decay is indicative of a heterogeneous kinetic condition, namely the formation of ion pairs. The product of the neutralization of these ions was the triplet state of the molecule ($G_{triplet} \sim 1$ at high concentrations), and a small yield of luminescence. This luminescence may indicate that a small yield (<0.25) of singlet excited states is formed. A large yield ($G_{triplet} > 2$) of triplet excited states, is formed in less than 1 nsec. It is suggested that these excited states are formed directly from subexcitation electrons. (auth)

21130 ISOTOPIC COMPOSITIONS OF THE HYDROGEN PRODUCED FROM LIQUID METHANOL-d_1 BY IRRADIATION OF ^{60}Co γ RAYS AND OF THE ^{10}B(n,α)^{7}Li RECOIL PARTICLES. Seki, Hiroshi; Imamura, Masashi (Inst. of Physical and Chemical Research, Tokyo). J. Chem. Phys., 48: 1866-7(Feb. 15, 1968).

Pure CH_3OD and methanolic solutions of $FeCl_3$ or N_2O were subjected to radiolysis with ^{60}Co gamma rays as well as with the high-LET recoil particles from the ^{10}B(n,α)^{7}Li reaction. Preliminary results showed that there may be no remarkable differences between CH_3OH and CH_3OD. Results showed rather great differences between gamma and recoil radiolysis. (M.C.G.)

21131 COMMENT ON INFLUENCE OF THE DIELECTRIC CONSTANT ON THE YIELD OF FREE IONS PRODUCED DURING RADIOLYSIS OF A LIQUID AND ON KINETICS OF POSITIVE CHARGE AND ELECTRON SCAVENGING. Burns, W. G. (Atomic Energy Research Establishment, Harwell, Eng.). J. Chem. Phys., 48: 1876-7(Feb. 15, 1968).

The first paper discussed appeared in J. Chem. Phys. 43, 86 (1965) and the second appeared in the same journal 46, 2822 (1967). These papers were abstracted for NSA and appeared as 19: 28386 and 21: 19669, respectively. (M.C.G.)

21132 ACTIONS CHIMIQUES ET BIOLOGIQUES DES RADIATIONS. ONZIEME SERIE. (The Chemical and Biological Action of Radiations. 11th Series). Haissinsky, M. Paris, Masson et Cie, Editeurs, 1967. 246p.

Four units are included; separate abstracts have been prepared for each. (J.G.B.)

For abstracts of individual sections see: 21133–21136.

21133 EFFECTS OF THE ELECTRIC AND MAGNETIC FIELD ON THE PHENOMENA AND CHEMICAL PROCESSES INDUCED BY IONIZING RADIATION. Talrose, V. L. (Inst. of Chemical Physics, Moscow). pp 85-130 of Actions Chimiques et Biologiques des Radiations. Haissinsky, M. Paris, Masson et Cie, Editeurs, 1967.

Chemical, electric, and mechanical phenomena occurring in an electric field are discussed. A short discussion of the effects of the magnetic field on radiolysis is also included. Ninety-six references are given. (J.G.B.)

21134 PRIMARY RADIOLYTIC YIELDS IN NEUTRAL OR ALKALINE AQUEOUS SOLUTIONS. Haissinsky, M. (Laboratoire Curie, Paris). pp 131-79 of Actions Chimiques et Biologiques des Radiations. Haissinsky, M. Paris, Masson et Cie, Editeurs, 1967. (In French).

Effects on the radiolytic transformations that can be attained a priori by increase of the pH from 0 to 14 were examined. These effects can have a purely chemical or radiolytic origin. The modifications that the primary radiolysis products of water, e^-_{aq}, H, OH, H_3O^+, H_2, H_2O_2, and HO_2, can undergo in the passage from the acid to neutral medium and from neutral to alkaline medium were also examined. Various neutral and alkaline systems that have been studied up to the present are reviewed in some detail. Forty-three references are included. (J.S.R.)

21135 GAS PHASE RADIOLYSIS OF HYDROCARBONS. Ausloos, P.; Lias, S.-G. (National Bureau of Standards, Washington, D. C.). pp 1-83 of Actions Chimiques et Biologiques des Radiations. Haissinsky, M. Paris, Masson et Cie, Editeurs, 1967.

Advances made towards understanding certain chemical phenomena through gas phase radiolysis of hydrocarbons are discussed. The five chapter topics include: experimental approaches used in the elucidation of radiolytic mechanisms; ion-molecule reactions; neutralization; ionic fragmentation; and, neutral excited molecules in the radiolysis. Fifty-three references are included. (J.G.B.)

21136 RADIATION CHEMISTRY OF SURFACES. Kohn, Harold W. (Oak Ridge National Lab., Tenn.). pp 181-230 of Actions Chimiques et Biologiques des Radiations. Haissinsky, M. Paris, Masson et Cie, Editeurs, 1967.

Various experiments on the radiation chemistry of heterogeneous systems consisting of a solid adsorbent plus adsorbate are reviewed. An attempt was made to substantiate the theory that reactive intermediates generated by irradiation of the solid surface react with the adsorbed phase, as a result of energy transfer phenomena which are essentially chemical in nature. (122 references). (J.G.B.)

21137 METHOD FOR PRODUCING DIBASIC FATTY ACIDS. Okada, Yoichi. Japanese Patent 1967-13766. Aug. 4, 1967. Filed Mar. 21, 1964.

A low, saturated, monobasic fatty acid or its anhydride is irradiated with ionizing radiation or uv rays in the presence of dinitrogen monoxide, in order to convert the monobasic into the dibasic fatty acid. The peculiar action of the dinitrogen monoxide results in a high yield and prevention of reversed or side reactions. (NSA of Japan)

21138 METHOD FOR CHLORINATING POLYETHYLENE IN THE FORM OF FIBER OR FILM BY IRRADIATION WITH AN IONIZING RADIATION. Sakurada, Ichiro (to Japanese Association for Radiation Research on Polymers). Japanese Patent 1967-13008. July 25, 1967. Filed Jan. 25, 1960.

Chlorinated fiber or film of polyethylene is produced by irradiating polyethylene with ionizing radiation in the presence of Cl_2. The dyeability, texture, and mechanical properties of the film are improved considerably by the process. (NSA of Japan)

21139 METHOD FOR TREATING POLYMERIC SUBSTANCES. Shinohara, Yasuo (to Toyo Rayon Co., Ltd.). Japanese Patent 1967-7684. Mar. 29, 1967. Filed Aug. 7, 1963.

The radiation-crosslinking of polymeric substances is promoted by contacting the polymers with acetylene or (especially) an aqueous solution of acetylene, either before, during, or after the irradiation. There is no limitation to the kinds of polymer, and the polymers may be in a powder or pellets or in any other form such as fabric or film. The method is applicable for polymers having a crosslinking tendency and also for polymers degraded by the irradiation, such as polypropylene and cellulose. The desirable acetylene concentration in the aqueous solution to be contacted with the polymers is over 0.005 vol %. The polymeric substance may be irradiated after absorption of an acetylene solution or immersed in the acetylene solution. The most convenient and effective method, however, is immersion of the polymer in acetylene-solution treatment at a high temperature. (NSA of Japan)

21140 METHOD FOR PRODUCING TETRAFLUOROETHYLENE POLYMER. Oshima, Keichi (to Industrial Research Inst.). Japanese Patent 1967-6508. Mar. 16, 1967. Filed Mar. 23, 1964.

$CHClF_2$ is added to C_2F_4 and the mixture is irradiated with high-energy ionizing radiation in the condensed phase below −20°C to give a polymer of C_2F_4. The advantage of this method is a high polymerization velocity, compared with that of the radiation polymerization of C_2F_4 alone, due to the solvent effect of $CHClF_2$. The polymerization velocity is dependent on the mole ratio of C_2F_4 in the mixture. For a radiation dose rate of 1.7×10^5 R/hr and a temperature of −79°C, for example, this velocity reaches a maximum, 47%/hr, with a C_2F_4 concentration of about 40%. Other advantages of the method include smooth polymerization without stirring due to the good miscibility of $CHClF_2$ with C_2F_4, and the good dispersion of the polymer in $CHClF_2$ due to the formation of polymer as a fine powder. (NSA of Japan)

21141 METHOD FOR GRAFT POLYMERIZING POLYMERS OF THE POLYESTER SYSTEM. Tomioka, Kenji (Toyo Rayon Co., Ltd.). Japanese Patent 1967-14472. Aug. 14, 1967. Filed Nov. 5, 1963.

A method is proposed for the rapid graft polymerization of polyesters under conditions of reduced radiation dosage to result in no change, either chemical or physical, to the polymers. When an unsaturated organic acid is graft-polymerized to a polymer of the polyester system by irradiation with an ionizing radiation, an inhibitor to prevent the sole polymerization of the organic acid is added to the reacting system, and a substitution compound of the benzene-system nucleus is also added in amounts smaller than 10% of the organic acid (or its liquid). Less than three substitution radicals must be present on the benzene nucleus. They are selected from the following: an alkali radical with 1 to 4 atoms of C and H and its substitution product, a phenyl radical and its nucleus substitution product, a halogen, an amino radical or its derivative, and derivatives of the carboxyl radicals. (NSA of Japan)

21142 METHOD FOR POLYMERIZING BUTADIENE. Tsuda, Teizo (to Toyo Rayon Co., Ltd.). Japanese Patent 1967-872. Jan. 18, 1967. Filed Dec. 17, 1963.

An improved method is proposed for the radiation-polymerization of butadiene by irradiating the monomer with high-energy radiation in the presence of Ag^+. The polymerization is carried out either by irradiating an aqueous solution of Ag salt while butadiene gas is bubbled through the solution, or by irradiating an ampule containing an aqueous solution of Ag salt and liquefied butadiene. The complex compound formed between butadiene molecule and Ag^+ has much higher efficiency for radiation polymerization than butadiene itself in the absence of Ag^+. The molar ratio of butadiene to Ag^+ in the complex compound molecule is 1:1. But only a small amount of Ag^+ is required because excess molecules of the monomer combine with Ag^+ successively to form molecules of the complex compound, from which Ag^+ are regenerated after the butadiene molecules are polymerized. In contrast with the ordinary polybutadiene in which trans-1,4 linkage predominates, the product polymer is rich in cis-1,2 structure, as shown by the infrared absorption spectra of the polymer. The Ag salts suitable for the method are water-soluble ones such as nitrate, borofluorite, and perchlorate, and the desirable concentration of Ag^+ in the aqueous phase is more than 1.0%; the radiation dose required for the polymerization is 10^3 to 10^7 RAD. (NSA of Japan)

21143 METHOD FOR CHLORINATING HYDROCARBONS BY IRRADIATION WITH AN IONIZING RADIATION. Danno, Hirobumi (to Japan Atomic Energy Research Inst.). Japanese Patent 1967-13842. Aug. 5, 1967. Filed Sept. 22, 1964.

A method is proposed for production of high yields of chlorinated hydrocarbons. A hydrocarbon or a chlorinated hydrocarbon is substitution-chlorinated in the presence of excess Cl_2 while being irradiated with high-energy ionizing radiation. (NSA of Japan)

21144 METHOD FOR PRODUCING RESINS OF THE POLYVINYL CHLORIDE SYSTEM. Yoshitake, Toshihiko (to Kurashiki Rayon Co., Ltd.). Japanese Patent 1967−13261. July 28, 1967. Filed Dec. 29, 1964.

A method is proposed for producing resins of the polyvinyl chloride system having good moldability and workability, high transparency, and high shock-resistance. The grafted resin in the form of powder, having a grafted content of 3 to 20 wt %, is first obtained either (1) by contacting the resin of the polyvinyl chloride system in the form of powder, irradiated with ionizing radiation, in such a way as not to destroy the form of powder, or (2) by contacting the same, but unirradiated, resin in a similar manner, while irradiated with ionizing radiation, to either of (1) an unsaturated compound of the diene system (or its solvent-solution) or (2) a monomer mixture of a 99 to 30 wt % diene and 1 to 70 wt % of a styrene-system monomer (or its solvent-solution). Then, to this grafted resin is added an ethylene-vinyl acetate copolymer (containing 40 to 70 mol % of ethylene) and the mixture is heated and kneaded together. (NSA of Japan)

21145 PROCESS FOR PREPARING TRIOXANE COPOLYMERS. (to Farbwerke Hoechst, AG.). British Patent 1,104,514. Feb. 28, 1968. Priority date July 25, 1964, Germany.

Trioxane and 1 to 50 wt %, calculated on the comonomer mixture of 1,3-dioxolane can be polymerized at a temperature of 0 to 80°C under the action of high energy radiation at a dose rate within the range of 10^3 to 10^9 RAD/hr. Polymerization can be carried out in the solid state or in a solution or suspension of a hydrocarbon or chlorohydrocarbon. A phenol, a urea derivative, a hydrazine derivative, an amide derivative, or an amide may be incorporated into the polymer as a stabilizer. (B.L.M.)

21146 RADIOISOTOPES. Woodburn, J. H. London, University of London Press, 1962. 128p. 21s.

The uses of radioisotopes in the fields of chemistry, physics, biology, agriculture, medicine, archeology, and industry are discussed. Section headings are as follows: radioisotopes in the service of science; calendars and clocks; signal-sending hospital and medical aides; radioisotopes as agricultural aides; radioisotopes at work in industry; radioisotopes in biology laboratories; radioisotopes in chemistry and physics laboratories; and how radioisotopes are made and how their signals are counted. (UK)

21147 PROCESS FOR POLYMERIZING TETRAFLUOROETHYLENE IN CONTINUOUS MANNER USING HIGH-ENERGY IONIZING RADIATION. Doumas, Arthur C. (to Dow Chemical Co.). U. S. Patent 3,342,899. Sept. 19, 1967. Filed July 20, 1962.

Tetrafluoroethylene can be readily polymerized or graft copolymerized continuously by feeding monomeric tetrafluoroethylene to a polymerization zone and into contact with a finely divided tetrafluoroethylene polymer suspended in water. A suspension of the tetrafluoroethylene in water is withdrawn from the polymerization zone, one portion of this suspension is fed to a filtering means in which the polymer is separated from the water, and the other portion is passed through a field of high energy ionizing radiation at an intensity of at least 40,000 RAD/hr and a radiation dose sufficient to initiate polymerization of monomeric tetrafluoroethylene. This suspension of irradiated polymer is then fed into the polymerization zone and contacted with a monomeric tetrafluoroethylene, which is fed into the polymerization zone at a rate not substantially greater than the rate at which the monomer is consumed in the polymerization reaction. (B.L.M.)

21148 PHENOMENA INVOLVING NEUTRON CAPTURE BY SELECTED COBALT COMPLEXES. Stucky, Gary Lee. Manhattan, Kan., Kansas State Univ., 1967. 244p.

Thesis.

An extensive investigation was made of the degradation products and other phenomena associated with neutron capture reactions

of six cobalt complexes. These complexes were hexamminecobalt(III) nitrate, potassium trioxalatocobaltiate(III), cobalt(II) dihydrogen EDTA, cobalt(III) acetylacetonate, cobalt(II) glycinate, and cobalt(III) glycinate. The complexes were irradiated in an integral neutron flux of 6.9×10^{16} neutrons cm^{-2} with concomitant γ dose of 5.5×10^{7} R so that specific activities of 0.4 to 0.7 mC g^{-1} were produced. An investigation was made into the behavior of decomposition products in both aqueous and nonaqueous solution media as a function of pH. Hexamminecobalt(III) nitrate showed an increase in retention from 13 to 22% change from aqueous to DMF-dissolution. Other complexes also showed degradation product distribution changes in various solvents. Recoil Co and retention values were correlated to pH change, the former decreasing in the pH range from 3 to 10. Direct correlation of ligand field splitting with quantity of retention species formed on neutron irradiation of the cobalt complexes studied was found in a linear relationship. Attempts were successfully made to correlate degradation product analysis by means such as paper electrophoresis, thin-layer chromatography, ion exchange, and paper chromatography. The ease of correlation of degradation product values was roughly proportional to the number and complexity of degraded, isolatable species produced by a given complex. Studies were made to relate the effects of phenomena such as magnetic susceptibility, solvent-solute interaction, and annealing, with the state of the irradiated solids during and subsequent to the recoil event. Infrared spectroscopy studies inferred hot atom effects causing deformation changes for both $Co(NH_3)_6(NO_3)_3$ and $K_3Co(C_2O_4)_3 \cdot 3H_2O$. Photodecomposition studies for the same two substances showed the inhibitor capacities of certain radiolabeled species present, which delay or prevent decomposition of the parent molecules by photons. All gaseous products evolved during the irradiations were identified as of low molecular weight and "simple" character. Both thermal and radiative annealing studies were conducted, affirming the complexity of decay and recombination rate processes among decomposition products present in the irradiated complex. X-ray annealing studies gave results unique from the thermal and γ ray treatments investigated. The data do not conclusively support any single proposed annealing model, but do favor the "cavity complex" and "variable depth electron donors-exchange" concepts. The analytical results affirm the existence of a multitude of factors affecting the product distribution in the hot atom chemistry of Co complexes. The phenomena observed establish the necessity of pursuing further studies in all three phases, for an improved understanding of the recoil event and of the subsequent behavior of the radiolabeled species. (Diss. Abstr.)

Radiochemistry

21149 MINIMUM CRITICAL ^{235}U ENRICHMENT OF HOMOGENEOUS, HYDROGENOUS URANYL NITRATE SYSTEMS. Bierman, S. R.; Hess, G. M. (Battelle Memorial Inst., Richland, Wash.). Nucl. Sci. Eng., 32: 135-9(Apr. 1968). (BNWL-SA-1379).

The data presented establish the minimum critical enrichment of ^{235}U in homogeneous uranyl nitrate at 2.104 with a standard deviation of 0.010 wt %. This results in a lower limit of 2.07 wt % at the 99% confidence level. Optimum neutron moderation for 2.14, 2.26, and 3.04 wt % enriched uranyl nitrate homogeneous systems occurs at H/U ratios of 8.0 ± 1.0, 9.3 ± 0.5, and 10.5, respectively. The minimum critical enrichment is the enrichment required to obtain an infinite neutron multiplication factor of unity under conditions of optimum moderation. (M.C.G.)

21150 DETERMINATION OF SPECIFIC ACTIVITY OF ^{131}I SOLUTIONS VIA AN IODIDE ELECTRODE. Arino, Hirofumi; Kramer, Henry H. (Union Carbide Corp., Tuxedo, N. Y.). Nucl. Appl., 4: 356-?(May 1968).

The specific activity of ^{131}I solutions was calculated from the measured ^{131}I activity and the total iodide content. The latter was measured rapidly (within five minutes) and accurately (relative standard deviation of ±1%) with a radiation-insensitive iodide-sensitive membrane electrode that permits accurate iodide measurements of commercially available "carrier-free" high activity ^{131}I solutions. (auth)

Separation Processes

Refer also to abstracts 21090 and 21754.

21151 (AERE-M-2008) SEPARATION OF SMALL QUANTITIES OF MERCURY FROM GROSS AMOUNTS OF SILVER IN NITRIC ACID SOLUTION. Maude, B. M.; Wilkinson, K. L. (Atomic Energy Research Establishment, Harwell (England)). Feb. 1968. 10p. Dep. CFSTI. UK 1s. 9d.

Methods investigated for the separation and recovery of mg quantities of stable mercury isotopes from gross amounts of silver in strong nitric acid solution are described. The method adopted was displacement from solution by copper, and recovery of the mercury from the Hg–Ag–Cu alloy by controlled heating in vacuum. Experiments with natural mercury showed recoveries in the range 96% to 99%. (auth) (UK)

21152 (ANL-7401) SEPARATION OF URANIUM FROM ITS FISSION PRODUCTS BY COMBINED ION EXCHANGE-SOLVENT EXTRACTION. Musich, J. R.; Orlandini, K. A.; Korkisch, J. (Argonne National Lab., Ill.). Jan. 1968. Contract W-31-109-eng-38. 12p. Dep.

The application of an ion exchange–solvent extraction (CIESE) system to the cation separation of U from its fission products in a tetrahydrofuran (THF)–nitric acid solvent system was investigated. The K_d, distribution coefficient, value for about 20 elements was determined. After the U was completely eluted from the column by the THF–HNO_3 eluent, the other metal ions absorbed on the column were eluted. The separation process was free of interference since no salting out agent or high-acid concentrations were necessary. Besides the analytical separation and purification of U, the THF–HNO_3 system may also be used for the separation of any two elements showing extremes in their K_d values. (D.H.M.)

21153 (ANL-7415) ANION-EXCHANGE BEHAVIOR OF TRANSPLUTONIUM ELEMENTS AND LANTHANIDES IN HYDROCHLORIC ACID-ORGANIC SOLVENT MIXTURES. Orlandini, K. A.; Korkisch, J. (Argonne National Lab., Ill.). Jan. 1968. Contract W-31-109-eng-38. 12p. Dep. CFSTI.

The influence of 20 water-miscible organic solvents on the adsorption of tervalent transplutonium and rare earth elements from hydrochloric acid media was investigated using Dowex 1 as the exchange resin. From the distribution coefficients that were determined in various organic solvent–hydrochloric acid mixtures, the conditions most suitable for a group separation of the transplutonium elements from the lanthanides are indicated. The best separation possibilities exist in mixtures that consist of 75 or 60% acetone and 25 or 40% concentrated hydrochloric acid and are 2M in lithium chloride. Under these conditions, the separation factors of the pair americium–ytterbium was 28.8 and 21.5, respectively, the former being higher by about a factor of 4 than that obtained in pure aqueous lithium chloride media. So far, however, separation experiments conducted by using this fact have not produced satisfactory results because of a considerable tailing effect in the elution of ytterbium. (auth)

21154 (BNWL-583) D2EHPA EXTRACTION RECOVERY OF NEPTUNIUM AND PLUTONIUM FROM PUREX ACID SLUDGE SOLUTIONS. Schulz, W. W. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). Mar. 1968. Contract AT(45-1)-1830. 44p. Dep. CFSTI.

A batch bis(2-ethylhexyl) ester of phosphoric acid (D2EHPA) solvent extraction process for recovery of neptunium and plutonium values from Purex Acid Sludge solution was developed. This process recovers 95 to 98% of both actinides in a small volume (concentration factor of about 9000) of product solution and purifies them from essentially all contaminants except for small amounts of iron and uranium. (auth)

21155 (IN-1173) CRITICALITY ASPECTS OF THE REVISED ZIRCONIUM DISSOLUTION SYSTEM AT THE IDAHO CHEMICAL PROCESSING PLANT. Morrison, W. G. (Idaho Nuclear Corp., Idaho Falls). Feb. 1968. Contract AT(10-1)-1230. 31p. Dep. CFSTI.

Soluble neutron poison has been used as the primary nuclear safety control for routine processing of irradiated reactor fuel. Extensive calculations based on carefully controlled experiments have established concentration limits for the soluble boric acid poison. Special safety circuits and rigidly enforced operating procedures have been used to maintain nuclear safety at a level commensurate with the high standards used throughout the plant. This innovation has permitted safe use of large non-geometrically safe dissolution equipment for semi-continuous processing of enriched U–Zr fuel with a resultant ten-fold increase in Zr fuel processing capacity. (auth)

21156 (NUMEC-3292-2) DETERMINATION OF ISOTOPIC SEPARATION FACTOR IN A DIMETHYL ETHER–BORON TRIFLUORIDE SYSTEM. [PART] I. McGahan, John F. (Nuclear Materials and Equipment Corp., Lewiston, N. Y. Niagara Div.). Feb. 8, 1967. Contract AT(40-1)-3292. 6p. Dep. CFSTI.

A sample of feed dimethyl ether-BF_3 complex was brought to equilibrium under total reflux during several runs. The one step fractionation factor was determined to be $\alpha = 1.012$ for the first run. This is in agreement with previously published data. Liquid decomposition product production could not be explained by thermal decomposition alone. (auth)

21157 (NUMEC-3292-3) MATERIAL BALANCE: BORON ISOTOPE SEPARATION COLUMNS. Period Covered: August 1966–February 1967. Hoynacki, Jerome J. (Nuclear Materials and Equipment Corp., Lewiston, N. Y. Niagara Div.). Apr. 15, 1967. Contract AT(40-1)-3292. 19p. Dep. CFSTI.

A continuing mass balance has been made on the boron isotope separation columns since October 28, 1966. The data covering earlier periods are included for comparative information. Tables summarize the results for each period. Graphs show the influence of the cooling water temperature on the vent loss. Diagrams show the distribution of mass and boron-10 for the period October 28, 1966 to March 1, 1967. An accountability for more than 99.9% of the mass and 97% of the boron-10 entering the system has been attained. The vent stream has been reduced to 50% of its previous value. The four long periods studied (October, November through December, January, and February) had 10.68, 20.97, 17.41, and 16.04% recoveries respectively of boron-10 from the feed material. The last two reported periods may be considered more typical as the plant was near steady state with only natural complex being used as feed. (D.L.C.)

21158 (UJV-1148) EXTRACTION OF NITRIC ACID, URANIUM, PLUTONIUM, AND FISSION PRODUCTS BY PHOSPHONATES, PHOSPHINATES, AND PHOSPHINE OXIDES. I. THE EXTRACTION OF NITRIC ACID AND URANYL NITRATE. Talas, M. (Ceskoslovenska Akademie Ved, Rez. Ustav Jaderneho Vyzkumu). Oct. 1967. 42p. Dep.

The extraction of nitric acid and uranyl nitrate with some butyl esters of phosphonic and phosphinic acid of the type $[BuO]_2$: PO.R and BuO.PO: R_2 [R = methyl, butyl, i-amyl, and phenyl group] and with some trialkylphosphine oxides R_3PO [R = butyl and hexyl group] was studied. The dependence of the extraction of nitric acid from uranium free solutions on the concentration of acid, salting-out agent, and solvent was investigated. Furthermore, the uranyl nitrite concentration dependence of nitric acid extraction was studied. Similar dependencies were investigated in the extraction of uranyl nitrate from acid and acid-deficient solutions. (auth)

21159 PROBLEMS POSED BY THE DECONTAMINATION OF STEEL BY ELECTROLYTIC MEANS. Miazek-Kula, M. Prace Cent. Inst. Ochrony Pracy, 17: No. 52, 59-65(1967). (In Polish).

The decontamination of acid-resistant steel contaminated with cobalt-60 using various electrolytes (0.2 and 2N sulfuric acid; 5 and 15% citric acid; and 1, 3, 5, and 15% oxalic acid) was studied. The relationship between the degree of decontamination, chemical-physical changes in the electrolyte, and changes in the decontaminated surface, was studied. Results indicated that within certain limits the amount of electric current transmitted by the electrolyte is unrelated to decontamination performance. Cathodic decontamination using sulfuric acid (current density 4.4 mA/cm²) was found to be most satisfactory from the standpoint of changes in surface condition. Least decontamination was obtained with oxalic acid in all concentrations and current densities tested. (Occup. Safety and Health Abstr., Vol. 5, No. 11, 1967)

21160 STUDIES ON CATION EXCHANGE EQUILIBRIA FOR THE URANYL–HYDROGEN SYSTEM. Hagiwara, Zenzi; Ochiai, Ken-ichi (Tohoku Univ., Sendai). J. Nucl. Sci. Technol. (Tokyo), 5: 104-10(Mar. 1968).

Selectivity coefficients of the uranyl-hydrogen ion exchange system were determined in a series of sulfonated polystyrene type cation exchange resins in three different degrees of crosslinkage at four different temperatures. The standard free energies of exchange ΔG° and the heats of exchange ΔH were also estimated from the data of selectivity coefficients determined on the same resins. In general, the selectivity coefficient increased with both crosslinkage and temperature, and decreased with increasing proportion of uranyl in the resin phase. The study was further extended to the exchange system of uranyl-ammonium in order to ascertain the validity of the magnitudes of selectivity coefficients obtained for the uranyl-hydrogen system. Good results were obtained on the exchange equilibria. (auth)

21161 THEORETICAL REMARKS ON THE CONTRIBUTION OF CHEMICAL REACTIONS TO ISOTOPE SEPARATION. Kakihana, Hidetake; Takahashi, Kimiko; Yato, Yumio (Tokyo Inst. of Tech.). J. Nucl. Sci. Technol. (Tokyo), 5: 93-7(Mar. 1968).

Fundamental equations for the isotopic separation factor were derived with consideration given to the role of chemical reactions. It is shown that the separation factor of isotopes can be divided into three terms, the isotope effects caused by the transfer of the species from the first to the second phase, and due to chemical reactions in the first phase and in the second phase. The first effect consists of three terms, the isotope effects caused by the pure physical transfer of isotopic species and by the hydration and solvation in the first phase and in the second phase. A discussion is given on the use of the above equation in seeking combinations of chemical systems that provide for better separation of isotopes. (auth)

21162 RAPID CHEMICAL SEPARATIONS FOR THE STUDY OF SHORT-LIVED ATOMIC NUCLEI. Herrmann, G. (Univ., Mainz). Angew. Chem. Int. Ed. Engl., 7: 78(Jan. 1968).

Rapid chemical separations of nuclides with half-lives of a few seconds are discussed. The acceleration of isotope and ion exchange and solvent extraction techniques are discussed. Nuclear-chemical effects that can be used for rapid separations include β-recoil from solid surfaces, through which the materials produced from short-lived β-emitters leave a sample and are deposited on a foil. More specific are chemical reactions between recoil atoms and gaseous reactants when these yield volatile compounds. The application of these procedures to the study of short-lived nuclides was illustrated by means of work carried out on neutron emitters present in fission products. After pulsed irradiation in the Mainz reactor, new neutron emitters of half-life down to 0.8 sec (^{140}I) were detected, and their contributions to delayed neutron emission on fission of uranium-235 by thermal neutrons were measured. (J.G.B.)

21163 THE EXTRACTION OF NEODYMIUM AND SAMARIUM BY DI(2-ETHYLHEXYL) PHOSPHORIC ACID FROM AQUEOUS CHLORIDE, PERCHLORATE, AND NITRATE SYSTEMS. Lenz, Terry G.; Smutz, Morton (Iowa State Univ., Ames). J. Inorg. Nucl. Chem., 30: 621-37(Feb. 1968).

Equilibrium data were obtained for the systems Sm^{3+}–H^+–H_2O–1M D2EHPA–Amsco (hydrocarbon diluent) with chloride, perchlorate, and nitrate as anions. It was observed that Sm was extracted from chloride media by the conventional ion-exchange reaction at low, moderate, and high aqueous Sm concentrations. Equilibrium data for the perchlorate and nitrate systems differed considerably from the data for the chloride system, due to the appearance of a second extraction reaction. The second extraction reaction involved the extraction of a neutral species. Separation factors for the Sm–Nd–perchlorate system are given a function of aqueous lanthanide concentration and aqueous acidity. These data show that the reaction involving the extraction of the neutral species is much less selective between Sm and Nd than the ion-exchange reaction. (auth) (UK)

21164 STEADY-STATE SOLVENT EXTRACTION CALCULATIONS FOR CURIUM RECOVERY. Eubanks, I. D.; Lowe, J. T. (E. I. du Pont de Nemours Co., Aiken, S. C.). Ind. Eng. Chem., Process Design Develop., 7: 172-7(Apr. 1968).

A numerical method has been programmed in FORTRAN IV for calculating steady-state phase concentrations in countercurrent liquid-liquid extractors. An integral number of stages, cocurrent mass transfer efficiencies, and compositions of multiple feed streams are included in the input data. Distribution data are represented by mathematical expressions for the specific process computed. Stage concentrations for as many as seven mutually dependent distributing components can be calculated from a single set of input data. Computed and experimental concentration profiles are compared for flowsheets used to purify curium. (auth)

21165 SOLVENT EXTRACTION OF THORIUM AND URANIUM FROM BERYLLIUM NITRATE FEEDS BY TRI-n-BUTYL PHOSPHATE. Cairns, R. C.; Baillie, M. G.; Fox, B. J.; Ryan, R. K. (Australian Atomic Energy Commission Research Establishment, Sutherland, Australia). Ind. Eng. Chem., Process Design Develop., 7: 177-81(Apr. 1968).

A solvent-extraction process was developed for the recovery of uranium and thorium from radioactive feed solutions highly salted with beryllium nitrate. By using a tri-n-butyl phosphate extractant and a split contactor system, in which the scrub raffinate and feed raffinate streams are kept separate, it was demonstrated that fission product decontamination factors greater than 10^3, and adequate uranium and thorium recoveries, can be obtained for activity levels up to 1 Ci per liter. (auth)

21166 EFFECT OF TEMPERATURE ON THE EXTRACTION OF NITRIC ACID, URANIUM, AND FISSION PRODUCTS WITH TRI-N-OCTYL AMINE. Tsujino, Takeshi; Ishihara, Takehiko (Japan Atomic Energy Research Inst., Ibaraki). J. Nucl. Sci. Technol. (Tokyo), 4: 353-60(July 1967).

With the aim of finding an optimum temperature in fuel reprocessing with alkylamine, the effect of temperature on the extraction of nitric acid, uranium, zirconium, and ruthenium with tri-n-octyl amine was investigated in the temperature range between 20 and 60°C. In the neutralization reaction for the extraction of nitric acid, $R_3N + H^+ + NO_3^- \rightleftharpoons R_3NHNO_3$, the apparent equilibrium constants were determined for various temperatures. The aver-

age enthalpy change, average free energy change and average entropy change were found to be −16.3, −7.2 kcal/mole deg, and −8.0 eu, respectively. For the association reaction of nitric acid, $R_3NHNO_3 + aHNO_3 \rightleftharpoons R_3NHNO_3 \cdot aHNO_3$, the average apparent enthalpy change was found to be 3.4 kcal/mole deg, which corresponds to hydrogen bond energy. The enthalpy change values were further determined for the extraction of uranium, zirconium, and ruthenium, and found to be −1.3, 6.1 and 9.3 kcal/mole deg, respectively. Within the temperature range studied, the lower regions of temperature appeared to provide better separation of fission products from uranium and from plutonium. (auth)

21167 RESEARCH AND DEVELOPMENT ON AQUEOUS PROCESSING. Stevenson, C. E.; Paige, D. M. Reactor Fuel-Process. Technol., 10: 303-8(Fall 1967).

Basic studies of the kinetics of acid dissolution of uranium and thorium are reported, and methods for the preparation of graphite–matrix, pyrolytic carbon (PyC)-coated particle fuels are reviewed. Operations for the recovery of enriched uranium and of plutonium from Pu–Al targets are described. Operating experience for the Windscale plant is reported. (auth)

21168 COMPACT PYROCHEMICAL PROCESSES. Miller, W. E.; Steunenberg, R. K. Reactor Fuel-Process. Technol., 10: 314-18(Fall 1967).

Pyrochemical processes for the decontamination and recovery of fissile and fertile constituents in irradiated reactor fuels are reviewed. Most of the processes currently under development employ liquid metals and salts as process solvents at temperatures in the range of 500 to 800°C. A process for the recovery of uranium and plutonium from fast breeder reactor fuels is described. Application of pyrochemical processing techniques to molten salt breeder reactor(MSBR) fuel is reviewed. A method for the removal of uranium and rare earth fission products from the core fuel and ^{233}Pa from the blanket salt is presented. (J.G.B.)

21169 PROGRESS IN WASTE-DISPOSAL RESEARCH AND DEVELOPMENT. Fineman, Phillip. Reactor Fuel-Process. Technol., 10: 319-21(Fall 1967).

Pacific Northwest Laboratory (PNL) is conducting a program that will demonstrate the solidification of high-level-activity wastes by various solidification processes. The processes are the PNL spray-solidification process, the ORNL (Oak Ridge National Laboratory) pot calcination and rising-level glass processes, and the BNL (Brookhaven National Laboratory) phosphate-glass process. Demonstration runs for each of the processes are discussed. (J.G.B.)

21170 REMOVAL OF FISSION PRODUCTS AND THEIR COMPLEXING AGENTS FROM DEGRADED SOLVENT BY ION EXCHANGE METHOD. Ohwada, Ken (Japan Atomic Energy Research Inst., Ibaraki). J. Nucl. Sci. Technol. (Tokyo), 4: 361-6(July 1967).

Removal of fission products and their complexing agents from chemically degraded TBP/kerosene and particularly from the kerosene diluent, was studied. With the use of column technique with mixed anion and cation exchange resins, more than 80% of the fission products and their complexing agents were removed. The carboxylic acids, which constitute one of the degradation products bringing about decrease of uranium extractability, were completely removed together with the complexing agents thereof by anion exchange resin. Removal was also obtained of monobutyl and dibutyl phosphoric acids (H_2MBP and HDBP), which can retain fission products and which in actual practice are liable to be formed by hydrolysis of TBP under intensive irradiation with concentrated nitric acid and/or at the elevated temperatures. (auth)

21171 ANION-EXCHANGE SEPARATION OF METAL IONS IN DIMETHYL SULPHOXIDE–METHANOL–HYDROCHLORIC ACID. Fritz, James S.; Gillette, Marcia Lehoczky (Iowa State Univ., Ames). Talanta, 15: 287-97(Mar. 1968).

The effects of dimethyl sulfoxide on the anion-exchange behavior of many elements in a methanolic system with hydrochloric acid were explored. Distribution coefficients for 26 elements were determined in a mixed solvent system of dimethyl sulfoxide–methanol to 0.6M hydrochloric acid, in which the proportions of dimethyl sulfoxide and methanol were varied. Lead(II) and silver(I) complexes are soluble in this system. Interesting effects were noted for gold(III), iron(III), molybdenum(VI), and uranium(VI). As a measure of the usefulness of the systems studied, 27 anion-exchange separations of two- to four-component mixtures of metal ions were carried out, each with quantitative results. (auth)

21172 FLUIDIZED-BED FLUORINATION OF UO_2–PuO_2–FISSION PRODUCT FUEL PELLETS WITH FLUORINE. Anastasia, L. J.; Alfredson, P. G.; Steindler, M. J. (Argonne National Lab., Ill.). Nucl. Appl., 4: 320-9(May 1968).

Fluorination of uranium and plutonium oxides to the volatile hexafluorides, UF_6 and PuF_6, in the fluid-bed volatility processing of spent Zircaloy-clad UO_2–PuO_2 power reactor fuel, was studied in a 2-in.-dia reactor using 0.3- to 1.2-kg charges of simulated spent fuel pellets containing UO_2, PuO_2, and nonradioactive oxides of elements that would be formed in fission. Retention of uranium and plutonium by the fluidized-bed of inert alumina, which is discarded after serving as a heat-transfer medium was minimized and amounted to only 0.02% of the uranium and 3.5% of the plutonium in a 0.65-kg pellet charge. The total plutonium retention was reduced to ~1% of the plutonium charge by using a single 1.2-kg bed of alumina to process three charges (1.95 kg) of fuel pellets. (auth)

21173 IMPROVEMENTS IN OR RELATING TO ION EXCHANGE MATERIALS. Hudswell, Fred; Waldron, John Clifford Hildrith (to United Kingdom Atomic Energy Authority). British Patent 1,104,654. Feb. 28, 1968. Filed July 19, 1965.

A method of deionizing water at a high temperature from a water-cooled reactor comprises passing the water through an ion exchange material consisting essentially of hydrated Ta_2O_5. The exchange material is made by fusing Ta_2O_5 or tantalite with KOH, dissolving the product in H_2O, adjusting the concentration of Ta calculated as Ta_2O_5 to be ≦5 g/l, and precipitating hydrated Ta_2O_5 with solid CO_2. (B.L.M.)

21174 METHOD FOR PRODUCING RADIOCHEMICALLY HIGH-PURITY ^{132}Cs. Tanaka, Kichizo (to Japan Atomic Energy Research Inst.). Japanese Patent 1966-14960. Aug. 23, 1966. Filed Nov. 2, 1962.

A method is proposed for production of large amounts of high-purity ^{132}Cs (very little ^{134}Cs) from reactor wastes and fallout. An organic or inorganic Cs compound is irradiated with γ rays of maximum energy >10 MeV to induce the reaction $^{133}Cs(\gamma,n)^{132}Cs$. (NSA of Japan)

21175 METHOD FOR REMOVING RADIOACTIVE MATERIALS IN A RADIOACTIVE LIQUID. Ida, Takao (to Ishikawa-ken Kogyo Shikenjo). Japanese Patent 1967-8520. Apr. 14, 1967. Filed Nov. 11, 1963.

Radioactive materials are removed by filtering the radioactive liquid through acid-activated diatomaceous earth containing clay minerals, etc. The method provides for the rapid and exhaustive removal of the radioactive materials, is simple to perform, and is inexpensive due to elimination of the use of expensive chemicals. (TSS)

21176 METHOD OF SEPARATION OF URANIUM FROM PLUTONIUM. Bathellier, Andre (to Commissariat a l'Energie Atomique). U. S. Patent 3,343,925. Sept. 26, 1967. Priority date Nov. 26, 1963, France.

A method of separating U and Pu consists of contacting an organic phase having a tributyl phosphate base and containing the nitrates of U and Pu in the tetravalent state with an aqueous phase containing H_2SO_4. Without reduction, the Pu nitrates are converted to sulfates, which are transferred to the aqueous phase due to the low solubility of $Pu(NO_3)_4$ in TBP solutions. The concentration of SO_4^- in the aqueous phase should be higher than 0.4N and not more than 2N. (B.L.M.)

21177 PROCESSES FOR THE RECOVERY OF URANIUM. Thomas, Thomas Garfield; Wilson, Stanley George (to United Kingdom Atomic Energy Authority). U. S. Patent 3,347,642. Oct. 17, 1967. Priority date Feb. 17, 1958, Great Britian.

Uranium is recovered from slag consisting of MgF_2 or CaF_2 arising from the production of UF_4 by leaching in a stainless steel vessel with HNO_3 at a temperature between 40 and 60°C. The final acidity of the leaching solution is between 0.5 and 5N. The nitrate leach solution may then be treated with any organic solvent suitable for U extraction. (B.L.M.)

EARTH SCIENCES

Geology and Hydrology

Refer also to abstracts 21146, 21194, 21195, 21206, 21226, 21298, and 21407.

21178 (BNWL-662) A STUDY OF REPORTED FAULTING IN THE PASCO BASIN. Brown, Randall E. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). Jan. 9, 1968. Contract AT(45-1)-1830. 55p. Dep. CFSTI.

Offset on faults normally ranges from a few tens of feet to a few hundred feet, the maximum is about 500 feet. In all cases faulting is secondary in importance to folding and developed simultaneously with that slow folding or possibly in the later stages of folding. Fault offset occurred where stresses were not relieved solely by folding. The termination of faults indicates that excessive stresses were local in nature or that they were easier dissipated by processes other than faulting at most places. Movement may have been by slow slippage unaccompanied by earthquakes. No evidence suggests that fault movement occurred abruptly, although uplift and folding appear to be continuing. The faults probably do not indicate earthquake activity. The Olympic–Wallowa lineament does not exist as a through-trending, near-surface structural or tectonic feature in the Wallula Gap to Rattlesnake Hills segment. Deep-seated structures may exist along the so-called lineament but their nature, orientation, continuity, whether they are in fact related in any way to the so-called lineament, and whether they are of any tectonic significance can yet only be inferred. Landslides appear to have formed in two main periods, neither necessarily related to earthquakes nor to faults or fault movement. The older period is believed to be during the repeated flooding of the Pasco Basin by glacial flood and meltwaters from about 20,000 to 10,000 years ago. Scattered, obviously more recent landslides are in some cases clearly attributable to irrigation and in some cases probably to periods of excessive precipitation. Most landslides formed where clay-rich beds are present, commonly where dips are steep. The Altithermal period of higher temperatures and less precipitation than earlier or later, from 8,000 to 4,000 years ago, may prove to be a time of little sliding. Some slide-like areas proved to be merely areas of complex geologic structure. Some of the clastic dikes in the late Pleistocene and early Recent glaciofluvial deposits (the Touchet beds and associated Pasco gravels) and associated rocks may in part reflect very shallow-seated (near-surface) earthquakes of local origin and extent. Such earthquakes could have occurred because of and during repeated rapid loading and unloading of the Pasco Basin by glacial flood waters. Geologic evidence, commonly related to earthquakes in other regions, is not equally indicative of earthquakes in the Pasco Basin. Earthquakes of significance may have occurred, but positive evidence for them is sparse or absent. (J.C.W.)

21179 (BNWL-SA-1596) ANALYSIS AND PREDICTIVE METHODS FOR GROUND WATER FLOW IN LARGE HETEROGENEOUS SYSTEMS. Nelson, R. William; Cearlock, Dennis B. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). Feb. 13, 1968. Contract AT(45-1)-1830. 14p. (CONF-671129-1). Dep. CFSTI.

From Symposium on Ground Water Hydrology, San Francisco, Calif.

Methods for analyzing and predicting ground water flow conditions in large heterogeneous systems are described and evaluated. Experience and results obtained through use of these methods in the study of ground water flow in the Hanford Atomic Energy Reservation are presented. It is concluded that ground water flow in heterogeneous porous materials can be rationally analyzed for actual field conditions by the new methods, and that the methods are particularly advantageous in that the definite specification of field data required results in savings by elimination of traditional but superfluous field data. Further progress in analyzing field situations and in ground water resources planning is anticipated. (L.C.L.)

21180 (CONF-670646) PROCEEDINGS OF THE SURTSEY RESEARCH CONFERENCE, REYKJAVIK, JUNE 25–28, 1967. (Surtsey Research Society, Reykjavik (Iceland). American Inst. of Biological Sciences, Washington, D. C.). 108p.

In November, 1963, a subterranean volcano erupted 20 miles off the South Coast of Iceland and Surtsey Island has consequently been born. A report is given including the history, geological and biological aspects, and the organizational achievements of the Surtsey Research Society. (J.C.W.)

21181 (DP-MS-68-23) TRACING SOIL MOISTURE AND GROUNDWATER FLOW AT THE SAVANNAH RIVER PLANTS. Fenimore, J. W. (Du Pont de Nemours (E. I.) and Co., Aiken, S. C. Savannah River Lab.). Mar. 1, 1968. Contract AT(07-2)-1. 24p. (CONF-680309-1). Dep. CFSTI.

From Conference on Hydrology in Water Resources Management, Clemson, S. C.

Management of solid waste, low level liquid waste, and high level liquid waste is summarized in regard to groundwater flow. Tracing methods of soil moisture are described. The geohydrology of the plant site is described. (J.C.W.)

21182 (HNS-9) AN EVALUATION OF CONTAMINATION OF GROUND WATER BY UNDERGROUND NUCLEAR DETONATIONS. I. PRELIMINARY STATEMENT OF PHENOMENA AND MAJOR PROBLEMS TO BE CONSIDERED. Davis, Stanley N.; Kaufman, W. J.; Kruger, Paul; Lawrence, D. C.; Werner, L. B. (Hazleton-Nuclear Science Corp., Palo Alto, Calif.). Apr. 19, 1962. Contract AT(29-2)-1229. 29p. Dep. CFSTI.

A ground water study program has been established. The program will be concerned with the problems of potential contamination of ground water by underground nuclear detonations and will assist in development of appropriate public safety measures. Various phenomena and problems include the radionuclides which result from underground nuclear detonations, their state and spatial distribution; effects of detonations on ground water water movement; prediction of radionuclides transport from knowledge of regional ground-water circulation, dispersion and sorptive reactions; and criteria to be applied to ground-water contamination. (J.C.W.)

21183 (HNS-38) SOME HYDROGEOLOGIC CHARACTERISTICS OF CRYSTALLINE ROCKS. Davis, Stanley N. (Bradberry (Carroll E.) and Associates, Los Altos, Calif.). May 20, 1963. Contract AT(29-2)-1229. 32p. Dep. CFSTI.

For Hazleton-Nuclear Science Corp., Palo Alto, Calif.

Water bearing properties of crystalline rocks are dependent on the occurrence of joints and faults and the extent of weathering Original porosity and permeability are so small in crystalline rock that, for most purposes, they can be ignored. Weathering commonly extends to depths of almost 100 feet. Joints tend to diminish in number with depth. Faults tend to close with depth. Thus, based on general geologic observations, permeability should decrease with depth. This conclusion is verified by a study of well-yield and water-injection data. Bulk permeabilities of most crystalline rock will be less than 0.03 darcy at depths greater than 1,000 feet. Most water in unweathered rock will flow through cracks which range in width from 0.001 to 0.1 centimeter. The wide variation in crack widths will give rise to large differences between calculated average ground-water velocities and actual maximum velocities. The maximum velocities may be from 4 to 100 times the calculated average velocities. (auth)

21184 (HNS-1229-46) REDISTRIBUTION OF RADIOCONTAMINANTS BY SURFACE WATER FLOWS. Preliminary Study. Nevin, Robert L. (Bradberry (Carroll E.) and Associates, Inc., Los Altos, Calif.). June 22, 1964. Contract AT(29-2)-1229. 31p. Dep. CFSTI.

For Hazleton-Nuclear Science Corp., Palo Alto, Calif.

A preliminary study was made of the potential for redistribution of radiocontaminants in a fallout area by surface water flows. The processes of transport and accumulation of radioactive material were investigated, and the capability for accurate hazard appraisals with present knowledge evaluated. Primary consideration was given to the problems that may be encountered in areas where useful applications of nuclear energy may be proposed in the future rather than the situations at test sites selected for their isolation and favorable climates. It was concluded that the mechanism for significant redistribution and concomitant contamination of water supplies probably will exist in some areas, but that present knowledge of erosion, sedimentation and the hydrochemical processes is insufficient for accurate predictions. It was concluded also that widely distributed deposits of contaminated particulate material could be accumulated by the processes of erosion and sedimentation and create long-term, continuing sources of contamination to water supplies. Further studies are recommended, including experimentation on the leaching, erosion and sedimentation of dissolved and adsorbed radionuclides. (auth)

21185 (N-66-21731) HET GEDRAG VAN DE BODEM EN HET GRONDWATER IN NEDERLAND BIJ DYNAMISCHE BELASTINGEN IN HET BIJZONDER ALS GEVOLG VAN EEN KERNWAPENEXPLOSIE. Verslag Nr 122. (The Behavior of the Soil

and Groundwater in The Netherlands in Dynamic Contamination, in Particular as a Result of a Nuclear Weapon Explosion. Report No. 122). Period Covered: 1962–1965. (Bureau der Genie, The Hague (Netherlands)). Sept. 1965. 333p. (In Dutch). (TDCK–43723).

As a large part of the Netherlands consists of terrain with a high ground water level, it is important to determine the behavior of water-saturated soil and ground water under dynamic contamination, particularly from the explosion of a nuclear weapon. The results of such a study are reported in detail. The behavior of soil and ground water under vibration was determined. The behavior of a construction in water-saturated soil under dynamic contamination was studied. The dynamic laboratory test apparatus was described. The effect of the soil composition on the radioactive fallout in The Netherlands was determined. The probability of fallout in The Netherlands was calculated. The shielding against the electromagnetic pulses originating from a nuclear explosion was calculated. (J.S.R.)

21186 (ORO–490–13) RADIOACTIVITY TRANSPORT IN WATER: TRANSPORT OF ^{85}Sr AND ^{137}Cs UNDER INDUCED CLAY SUSPENSIONS. Purushothaman, Krishnier; Gloyna, Earnest F. (Texas Univ., Austin. Environmental Health Engineering Research Lab.). Jan. 1968. Contract AT(11-1)-490. 132p. (CRWR–21; EHE–12–6701). Dep. CFSTI.

The effects of induced clay suspensions on the transport of ^{85}Sr and ^{137}Cs in aqueous environments are described. An instrumented flume was used as a model river to simulate an environment typical of a slow-moving, unpolluted, turbid stream. Modified longitudinal dispersion relationships were used to describe the transport of radionuclides in turbid streams. Data were derived from instantaneous release of ^{85}Sr and ^{137}Cs with suspended Attapulgite and Kaolinite clays. Continuous release of ^{137}Cs with an Attapulgite clay suspension helped to establish uptake and transport characteristics for one environmental condition. Aquaria and laboratory studies preceded the model river experiments to define more specifically some of the physical and chemical characteristics. Suspended clay in the model river system produced a significant reduction in the transport of ^{137}Cs. Conversely, the transport of ^{85}Sr was not affected appreciably since most of the ^{85}Sr remained in solution. (auth)

21187 TRACE ELEMENTS IN COMMON ROCK TYPES AND THEIR RELATIVE IMPORTANCE IN NEUTRON-INDUCED RADIOACTIVITY CALCULATIONS. Day, Walter C.; Paul, Roger A. (Univ. of California, Livermore). Health Phys., 14: 311–29(Apr. 1968).

The chemical composition of the rock surrounding an underground nuclear detonation must be known or assumed when calculations of the resulting neutron-induced radioactivity are attempted. A typical chemical analysis of rock samples does not include certain trace elements which have high neutron-capture cross sections. A literature search was undertaken to determine the average and range of content of these trace elements in common rock types, to permit an evaluation of their relative importance in neutron-induced radioactivity calculations. The elements considered in the study were Dy, Gd, Eu, Sm, Nd, Cd, Ag, Co, Cr, V, Sc, Cl, S, B, and Li. Data are reported giving the contents of these elements in ten igneous rock types and three sedimentary rock types. The five elements Gd, Eu, Sm, B, and Cl were found to occur in most rock types in quantities which would significantly affect neutron-induced radioactivity calculations. Calculations of induced radioactivity were performed for granite using maximum, average, and minimum trace element values obtained from the literature search. Calculations were also performed using average trace element values for four other igneous rocks and three sedimentary rocks. It is concluded that, in general, use of the average values for trace elements presented in this paper is adequate for assessing the quantities of radionuclides induced external to the device for use in feasibility studies for large scale excavation projects and other underground nuclear detonations when detailed chemical analyses of emplacement media are not available. (auth)

21188 BURIED-SOURCE MODEL FOR COMPUTING FALLOUT GROUND ROUGHNESS EFFECTS. French, R. L. (Radiation Research Associates, Inc., Fort Worth, Tex.). Health Phys., 14: 331–8(Apr. 1968).

Most calculations of the gamma radiation environment produced by fallout assume that the radioactive material is uniformly deposited on a smooth ground surface. A recent study of possible mathematical models for including the effects of ground roughness on the gamma-ray energy and angle distributions in air above fallout placed emphasis on the "buried source model." This model is based on the assumption that the fallout is covered by a uniform layer of soil whose thickness corresponds to the degree of ground roughness. Uncollided and singly scattered photon energy and angle distributions 3 ft above several different ages of fallout were computed as a function of source depth using the buried-source model. After adjusting the results to account for the multiply scattered component (approximately ten percent of the total), comparisons were made with gamma-ray energy and angle distributions measured over fallout deposited on a dry lake bed and on rough desert terrain. The comparisons indicate that the buried-source model adequately predicts the gross effects of ground roughness. In addition, the calculations performed employing the model provide some interesting insight on the detailed effects of ground roughness. (auth)

21189 ^{231}Pa METHOD OF DATING CORAL FROM BARBADOS ISLAND. Ku, Teh-lung (Woods Hole Oceanographic Institution, Mass.). J. Geophys. Res., 73: 2271–6(Mar. 15, 1968).

To investigate the feasibility of the ^{231}Pa growth method of dating marine carbonates, measurements of protactinium, as well as of uranium and thorium isotopes, have been made on unaltered coral samples taken from the Island of Barbados. Because analyses of a living species from this island indicate the presence of an insignificant amount of initial ^{231}P, ages of the fossil samples can be calculated from the extent to which ^{231}Pa has grown toward secular equilibrium with its radioactive parent ^{235}U. The three lowest coral reef terraces on the island have $^{231}Pa/^{235}U$ ages close to 80,000 years, 105,000 years, and 120,000 years. These ages are consistent with the ages estimated independently from the $^{230}Th/^{234}U$ ratios. This agreement suggests that the ^{231}Pa growth method has the potential of being a useful geochronometer as well as an independent check for the ^{14}C and ^{230}Th dating methods for marine carbonates in the age range of 10,000 to 120,000 years. The $^{231}Pa/^{235}U$ and $^{230}Th/^{234}U$ ages (taking $t_{\frac{1}{2}}$ ^{230}Th = 75,200 years) are in better accord if one uses 34,300 years rather than 32,480 years as the half-life for the nuclide ^{231}Pa. (auth)

21190 ^{137}Cs GAMMA-RAY ABSORPTION AND DENSITY OF ROCKS. Vankova, Vera (Geophysical Inst., Prague). Stud. Geophys. Geod., 12: 63–73(1968).

The dependence of the absorption coefficient μ of rocks on their density q is not strictly linear and should be approximated by a curve. This curve with a small curvature can be replaced by straight lines derived either for shorter density ranges or for groups of similar rock type, thus roughly accounting for the influence of chemical composition of rocks. Relatively small values of mean quadratic errors with all the groups indicate that on the basis of measuring the absorption coefficients μ, the density q can be estimated with an accuracy of about 1% or better. (auth)

21191 MINERAL AGES FROM THE FINNISH PRECAMBRIAN. Kouvo, Olavi; Tilton, G. R. (Carnegie Institution of Washington, D. C.). J. Geol., 74: 421–42(1966).

The number of isotopically dated zircons from the basement complex of the Karelian belt was doubled to include six samples. The ages are all discordant and are compatible with loss of lead by a continuous diffusion mechanism. Two possible mechanisms are that diffusion took place at a constant value of the parameter, D/a^2, or under conditions such that D/a^2 increased linearly in proportion to the amount of radiation damage. The lead age data are also compatible with an episodic loss of lead about 500 million yr ago, but there is no evidence that episodic loss should have occurred at that time. The regional metamorphism which affected the rocks 1,700 to 1,900 million yr ago, as recorded by the mica age values, did not seriously alter the uranium-lead ratios in the zircons of the pre-Karelian basement complex; however, zircon from the gneiss domes to the west may have experienced some lead loss as a result of the regional metamorphism. Four detrital zircon samples from Svecofennian schists near Tampere have discordant isotopic ages suggesting an age of 2,300 million yr. Since igneous rocks of this age are as yet unknown in Finland, the value is provisional. Zircon from a granodiorite intruding the schists has a nearly concordant age of 1,900 million yr. Comparison of the zircon ages from the schists and granodiorite shows that the 1,900 million yr age must represent the time of crystallization of zircon in the granodiorite, not a time of resetting as a result of intense metamorphism. These data strengthen the conclusions of earlier studies that plutonic rocks associated with both the Karelian and Svecofennian orogenic belts crystallized at about the same time. Data bearing on the retention of lead in zircon are presented. Zircon in a lens of schist 40 × 150 m. enclosed in the 1,900 million yr granodiorite mass has not had its age record erased in spite of the fact that the zircons in the schist must have been heated to the temperature of the intrusive mass. Other data in the literature establish that loss of lead from zircon may take place under less severe conditions. The uranium and thorium content of the samples appears to be one factor controlling lead loss, samples having high radioactivity losing lead more readily. This effect is probably

caused by radiation damage to the crystal structure or by inhomogeneous distribution of radioactivity. (auth)

21192 MEASUREMENT OF RADIOACTIVITY OF THE WATERS OF THE MEUSE AND OF FALLOUT IN BELGIUM DURING THE YEAR 1966. Govaerts, J.; Guillaume, M.; Gerardy, J.; Walch, N. (Univ., Liege). Bull. Soc. Roy. Sci. Liege, 36: 510-14(1967). (In French).

Results obtained in determining the content of ^{137}Cs and ^{90}Sr in samples of water from the Meuse River are given. The method of procuring the samples is described. Results are also included for the ^{137}Cs and ^{90}Sr content in fallout in Belgium in 1966. The 1966 analysis is compared with those made in the three preceding years. (F.S.)

21193 URANIUM, RADIUM, AND THORIUM CONTENT IN PHOSPHATE ROCKS AND THEIR POSSIBLE RADIATION HAZARD. Menzel, Ronald G. (Dept. of Agriculture, Beltsville, Md.). J. Agr. Food Chem., 16: 231-4(Mar.-Apr. 1968).

A survey of phosphate rock samples from all major phosphate-producing areas of the world showed that phosphate rocks from Florida, the main source of fertilizer phosphates in the United Stated, ranked relatively high in content of uranium, radium, and thorium. In areas where crops are fertilized with high rates of phosphate from Florida, the addition of uranium and radium may equal the amounts occurring naturally in the plow layer of soils, but the addition of thorium would be less than the amount occurring naturally. The radiation hazard, which might result from uptake of radium into food plants, appears to be negligible. (auth)

Meteorology

Refer also to abstracts 21227 and 21496.

21194 (A/AC.82/G/L-1171) NAKOPLENIE ISKUSSTVENNYKH RADIONUKLIDOV NA ZEMNOI POVERKHNOSTI V RAIONE G. LENINGRADA V 1954-1965 GG. (Accumulation of Artificial Radionuclides on the Earth's Surface in the Leningrad District in 1954-1965). Gedeonov, L. I.; Gritchenko, Z. G.; Flegontov, V. M.; Zhilkina, M. I. (Gosudarstvennyi Komitet po Ispol'zovaniyu Atomnoi Energii SSSR, Moscow). 1967. 7p. (In Russian). Dep.

Data characterizing the accumulation of all the fission products and the individual radionuclides on the ground surface in the Leningrad District from 1954 to 1965 are presented. It was shown that the accumulated fallout activity during the accumulation period undergoes great fluctuations, increasing with some delay after the series of tests and decreasing during the moratorium. Particularly sharp decreases were noted in 1960, from January to August 1961, and in 1965. Long-lived radionuclides of ^{90}Sr and ^{137}Cs were less strongly detected in the series of nuclear tests made in 1961, but was significantly ejected in the tests of 1961 to 1962, causing a sharp increase of the degree of accumulation on the earth's surface. At the end of 1965 the rate of accumulation of the radionuclides with the half-lives of 30 to 65 days (^{89}Sr, ^{91}Y, $^{95}Zr + Nb$, ^{103}Ru, ^{144}Ce) from the test explosions made in 1961 to 1962, decreased to zero. The accumulation of $^{144}Ce + ^{144}Pr$ was 120 $\mu Ci/km^2$, ^{106}Ru was 41 $\mu Ci/km^2$, ^{90}Sr was 41 $\mu Ci/km^2$, and ^{137}Cs was 82 $\mu Ci/km^2$. (tr-auth)

21195 (A/AC.82/G/L-1201) UROVNI RADIOAKTIVNOGO ZAGRYAZNENIYA PRIZEMNOGO SLOYA ATMOSFERY I POVERKHNOSTI ZEMLI PRODUKTAMI YADERNYKH VZRYVOV V 1963-1965 GG. V PODMOSKOV'E. (Levels of Radioactive Contamination of the Ground-Level Atmospheric Air and of the Earth's Surface From Products of Nuclear Explosions in 1963-1965 in the Vicinity of Moscow). Brendakov, V. F.; Davydov, E. N.; Gaziev, Ya. I.; Malakhov, S. G.; Nazarov, L. E.; Silant'ev, A. N.; Makhon'ko, K. P.; Churkin, V. N.; Shulepko, Z. S. (Gosudarstvennyi Komitet po Ispol'zovaniyu Atomnoi Energii SSSR, Moscow). 1967. 11p. (In Russian). Dep.

Data from the systematic measurement of the concentration of aerosol products of nuclear explosions in ground-level atmosphere, their fallout from the atmosphere, and their concentration in the upper ground levels (0 to 10 cm) in the vicinity of Moscow from 1963 to 1965 are presented. (tr-auth)

21196 (A/AC.82/G/L-1202) SRAVNENIE REZUL'TATOV IZMERENII ATMOSFERNYKH VYPADENII STRONTSIYA-90 V RAZNYKH STRANAKH. (Comparison of the Results of Measurements of Atmospheric Fall-Out of ^{90}Sr in Various Countries). Pudovkina, I. B. (Gosudarstvennyi Komitet po Ispol'zovaniyu Atomnoi Energii SSSR, Moscow). 1967. 26p. (In Russian). Dep.

The average characteristics of the fallout of ^{90}Sr, obtained in different countries at the same latitude were compared. There was good agreement of the data on monthly fallout of ^{90}Sr, equal to less than 1.0 $\mu c/km^2$. For high levels of fallout a systematic increase of the measurement of other countries above that of the radiation monitoring network of the Soviet Union was noted of as much as 20%. It was shown that the increase can be attributed to the different methods of measurement used. (tr-auth)

21197 (BMwF-FBK-67-79) RESEARCH ON THE ATTACHMENT OF NEUTRAL AND ELECTRICALLY CHARGED DECAY PRODUCTS OF RADIOACTIVE INERT GASES TO AEROSOLS. Progress Report, January 1-December 31, 1966. (Max-Planck-Institut fuer Kernphysik, Heidelberg (West Germany)). Sept. 1967. 80p. (In German). Dep.

Large-scale measurements of attachment properties of neutral and electrically charged decay products to aerosols were carried out. The object of these investigations was to determine the size distribution of an aerosol (the naturally occurring aerosol was used) in the submicroscopic range by means of a new-developed method and to measure the coefficient for attachment and the mean time for neutral decay product capture to a given aerosol mixture. (auth)

21198 (BNWL-578) AEROSOL DEPOSITION FROM TURBULENT AIRSTREAMS IN VERTICAL CONDUITS. Sehmel, G. A. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). Mar. 1968. Contract AT(45-1)-1830. 74p. Dep. CFSTI.

The general equations of continuity are set up to describe deposition of particles in which the eddy diffusivity is related to the Reynolds stress. Simplifying assumptions in the general equations as well as simplifying assumptions to obtain a workable model are discussed. The general equations are used as a basis from which to discuss existing models of turbulent deposition. A model is being developed for the case of deposition in tubes. Deposition velocities are shown using the initial assumptions for solving the model. The deposition of 1 to 28 μ particles was measured in lengths of 0.21, 0.62, 1.152, and 2.81 in. ID aluminum tubes. Uranine or uranine-methylene blue particles of a narrow size range generated with a spinning disc aerosol generator were passed through the tubes. The deposition data are reported as deposition velocities for each tube size as a function of flow rate, or Reynolds number, and particle size. Deposition velocities are from about 10^{-4} to 10 cm/sec. In general, for a given particle size and tube diameter, the deposition velocity remains low at about 10^{-4} cm/sec as the Reynolds number is increased above 2000 which is the flow transition region from laminar to turbulent flow. As flow becomes more turbulent, the radial motion of the particles becomes increasingly greater. This causes deposition to increase rapidly with Reynolds number. Above critical turbulent Reynolds number ranges, the deposition velocity increases rapidly as the Reynolds number is increased. These ranges of rapid initial increase start for Reynolds numbers from about 2,000 to 50,000. The Reynolds numbers required are a function of particles size and tube size. For further increases of Reynolds number, the deposition velocities increase to the order of 10 cm/sec. At still higher Reynolds numbers, the apparent deposition velocity decreases below the order of 10 cm/sec due to particle re-entrainment from the tube surfaces. This decrease was observed to be down to an apparent deposition velocity as low as 10^{-3} cm/sec for the range of variables shown. For these same conditions, the deposition velocity will remain at about 10 cm/sec, if re-entrainment is minimized by covering the tube surface with a tacky coating. The tacky coating may also increase the deposition for the region in which the deposition velocity increases rapidly with Reynolds number. Conditions exist for which the deposition velocity for 2 μ diam particles is increased one magnitude by the tacky coating. This indicates that the 2 μ particles are re-entrainable. (auth)

21199 (HASL-184) FALLOUT PROGRAM. Quarterly Summary Report, September 1-December 1, 1967. Hardy, Edward P. Jr.; Rivera, Joseph (New York Operations Office (AEC), N. Y. Health and Safety Lab.). Jan. 1, 1968. 414p. Dep. CFSTI.

The summary report consists of a total of fourteen interpretive reports and papers. A separate abstract was prepared for each of seven of these reports and papers. Papers for which no abstracts were prepared are concerned with fallout deposition, radiostrontium in milk and water, activities in Project Stardust, ^{37}Cs in Chicago food, and activities at Ispra in northern Italy. (J.R.D.)

For abstracts of individual papers see: 21020, 21200-21204, and 21496.

21200 (HASL-184, pp I.2-10) FALLOUT OF ^{238}Pu FROM THE SNAP-9A BURNUP. [PART] III. Volchok, Herbert L. (New York Operations Office (AEC), N. Y. Health and Safety Lab.).

Plutonium-238 was released by the disintegration of a SNAP-9A

power source upon re-entry into the atmosphere in April of 1964. It was estimated that the re-entry took place at an altitude of 46 kilometers over the Indian Ocean. Data are presented on the content of ^{238}Pu in fallout samples collected monthly at Melbourne, Australia, and New York City from 1966 through July 1967. (C.H.)

21201 (HASL-184, pp I.53-118) SEASONAL STRATOSPHERIC DISTRIBUTION OF ^{109}Cd, ^{238}Pu, AND ^{90}Sr. Telegadas, K. (Environmental Science Services Administration, Silver Spring, Md. Air Resources Labs.).

A series of latitudinal cross sections of the stratospheric concentrations of ^{109}Cd, ^{238}Pu, and ^{90}Sr is presented. General observations concerning meteorological factors that caused changes in the concentration of these isotopes are discussed. Data used as the basis of discussions are the result of analysis of atmospheric particles collected at altitudes of about 25,000 to 125,000 ft. (J.R.D.)

21202 (HASL-184, pp I.119-223) PROJECT AIRSTREAM. Krey, Philip W. (New York Operations Office (AEC), N. Y. Health and Safety Lab.).

Project Airstream is devoted to study of lower stratospheric radioactivity. Sampling missions using aircraft were scheduled for Aug. and Nov. 1967 and for Feb. and May 1968. The missions for Aug. and Nov. 1967 were completed. Data are included on samples taken over north, central, and south America. Discussions are included concerning debris from the Chinese 7th nuclear test, stratospheric radioactivity distribution in Oct. and Nov. 1967, and on radon concentrations. (J.R.D.)

21203 (HASL-184, pp II.6-25) SURFACE AIR SAMPLING PROGRAM. Volchok, Herbert L.; Kleinman, Michael T. (New York Operations Office (AEC), N. Y. Health and Safety Lab.).

A program devoted to study of the spatial and temporal distribution of nuclear weapons debris in surface air is described. The sampling network is located along the 80th meridian (W) extending from 76°N to 63°S. The activity concentrations in surface air during 1966 of ^{54}Mn, ^{55}Fe, ^{89}Sr, ^{90}Sr, ^{95}Zr, ^{109}Cd, ^{144}Ce, ^{238}Pu, and ^{239}Pu are tabulated. (J.R.D.)

21204 (HASL-184, pp II.26-86) HIGH-ALTITUDE BALLOON SAMPLING PROGRAM. Krey, Philip W. (New York Operations Office (AEC), N. Y. Health and Safety Lab.).

The collection of samples using balloons from October 1966 through June 1967 is reported. During this time interval, monthly collections were made at three or more altitudes up to a maximum of 41 km over Alaska, Texas, Brazil, and Australia. Because of unique activity distributions which were observed after the 6th Chinese nuclear test, a special set of balloon flights were conducted during early October from Foss Field, South Dakota (43° 34′ N). Aircraft samples collected at 15 to 20 km during the period February 1966 to August 1966 were obtained from the Stardust Program. The analyses of these aircraft samples will provide the area of intercomparison and correlation between the Stardust and High Altitude Balloon samples. Total gamma measurements and gamma spectra of each sample are obtained under uniform geometry. Selected filters are analyzed for fission products, plutonium isotopes, and other radionuclides of current interest. (J.R.D.)

21205 (MLM-1464) ENVIRONMENTAL MONITORING REPORT: JULY-DECEMBER 1967 AND 1967 SUMMARY. Anderson, H. F.; Sheehan, W. E. (Mound Lab., Miamisburg, Ohio). Jan. 15, 1968. Contract AT(33-1)-Gen-53. 46p. Dep. CFSTI.

The concentration of radioactive materials detected in the environment is reported. The average concentration of radionuclides in the Great Miami River and in the environmental air (average of all zones) was within the standards specified. (auth)

21206 (NEIC-RR-29) STABLE AND RADIOACTIVE LEAD IN ENVIRONMENT AND HUMAN BODY. Jaworowski, Z. (Institute of Nuclear Research, Warsaw (Poland)). 1967. 88p. Dep.

The origin, abundance, and isotopic composition of the stable and radioactive lead in the environment and in the human body are discussed. Methods for the determination of stable and radioactive lead are described. Temporal and geographic distribution of stable and radioactive lead in the environment are presented. Metabolic and toxicalogical studies of stable and radioactive lead in the human body are described. (R.C.K.)

21207 (NYO-3317-3) TRANSPORT AND DIFFUSION OF STRATOSPHERIC RADIOACTIVITY BASED ON SYNOPTIC HEMISPHERIC ANALYSES OF POTENTIAL VORTICITY. Final Report, Part 3. Danielsen, Edwin F. (Pennsylvania State Univ., University Park). Nov. 1967. Contract AT(30-1)-3317. 97p. Dep. CFSTI.

Ertel's potential vorticity theorem is generalized to apply to bulk parcels which move with the mean or large-scale synoptic velocities. The mean velocities are obtained from the stream function which is derived by numerical solution of the balance equation on isentropic surfaces. Criteria for the solution were determined by hand analyses of vorticity and potential vorticity over the northern hemisphere above 20N. On the basis of the machine analyses of potential vorticity and machine-computed isentropic trajectories the transport and diffusion of the potential vorticity are studied. Measurements of radioactivity are used to test the assumption that the potential vorticity in the lower stratosphere is positively correlated with stratospheric radioactivity, and that the changes in potential vorticity due to mixing should correspond to similar changes in the concentration of radioactivity. The results support the assumption; therefore the machine diagnostic and trajectory methods developed for this study are apparently sufficiently accurate to permit synoptic investigations of stratospheric radioactivity and ozone in terms of the distribution, movement, and destruction of potential vorticity. (auth)

21208 (RA-31) GROSS RADIOACTIVITY OF AIRBORNE DUST: RESULTS OF MEASUREMENTS DURING 1966. van Dongen, R.; Moonen, H. P. M.; Wolf, H. J. (Rijks Instituut voor de Volksgezondheid, Utrecht (Netherlands)). Dec. 1967. 15p. Dep.

Gross long-lived alpha, beta and gamma activities of airborne dusts, collected at De Bilt/Bilthoven, The Netherlands, during 1966, are reported. A discussion of some results is given. (auth)

21209 (SC-RR-66-2693) INVESTIGATION OF TMAE AS A CHEMILUMINESCENT ATMOSPHERIC TRACER. Elrick, R. M.; Smith, R. E. (Sandia Corp., Albuquerque, N. Mex.). May 1967. Contract AT(29-1)-789. 57p. Dep. CFSTI.

TMAE is a chemiluminescent liquid which is attractive for use as a tracer in studying the fall and dispersion of particles released in the atmosphere. TMAE field tests were conducted at the Tonopah Test Range and results suggest quantitative limits on the use of photographic and TV coverage for tracking clouds of particles in the atmosphere. (auth)

21210 FALLOUT OVER SOUTH AFRICA FROM NUCLEAR WEAPONS TESTED BY FRANCE IN 1966. Van As, D.; Basson, J. K. (Atomic Energy Board, Pelindaba, South Africa). Health Phys., 14: 307-9(Apr. 1968).

Measurements on airborne and deposited fallout over South Africa, resulting from the French nuclear detonations during 1966 in the South Pacific, are reported, with transit time and age analyses. (auth)

Mineralogy and Exploration

21211 RADIATION DAMAGE IN SCHAENTZEL URANIFEROUS COAL. Jedwab, Jacques (Univ. Libre, Brussels). Geol. Rundsch., 55: 445-53(1965). (In French).

Mineralographic and autoradiographic studies of Schaentzel coal shows the superimposed character of U mineralization and its mode of introduction and fixation. Coal devoid of inclusions or fractures has a very low activity. A relation between local increase in reflectivity and the amount of U present is noted. Entry of U is through pyrite; fixation is in sulfates. Fissures containing U have halos. Those which do not have U do not have halos, so that oxidation phenomena without the intervention of irradiation may be studied. Apparently there is no sedimentary control. No principal difference between the activity of visible and inframicroscopic minerals is noted; the difference is in the degree of condensation of the mineral material. Combination of the autoradiographic and micrographic techniques permit the evaluation of the existence of discrete minerals or homogenous U-C associations. (BBB)

Oceanography

Refer also to abstract 22921.

21212 (NYO-3109-28) RISING-PLUME PROBLEM IN THE SEA. Preliminary Report. Okubo, Akira (Johns Hopkins Univ., Baltimore, Md. Chesapeake Bay Inst.). July 1967. Contract AT(30-1)-3109. 14p. Dep. CFSTI.

A mathematical model is derived for an underwater plume which would result from convective currents rising from a heat source located on the bottom of the ocean. The plume could produce an upswelling of nutrient-rich waters beneficial to fisheries. The model assumes a continuous point source emitting heat verti-

cally upward into unstratified water at rest. Solutions are given for conditions of uniform temperature and salinity in the ambient water. (L.C.L.)

21213 (NYO–3109-29) RISING-PLUME PROBLEM IN THE SEA. Second Report. Okubo, Akira (Johns Hopkins Univ., Baltimore, Md. Chesapeake Bay Inst.). Sept. 1967. Contract AT(30-1)-3109. 15p. Dep. CFSTI.

A mathematical model is derived for an underwater plume which would result from convective currents rising from a heat source located on the bottom of the ocean. The plume could produce an upswelling of nutrient-rich waters beneficial to fisheries. The model assumes a continuous point source emitting heat vertically upward into stably stratified water at rest. (L.C.L.)

21214 (NYO–3109-30) RISING-PLUME PROBLEM IN THE SEA. Third Report. Okubo, Akira (Johns Hopkins Univ., Baltimore, Md. Chesapeake Bay Inst.). Dec. 1967. Contract AT(30-1)-3109. 22p. Dep. CFSTI.

A mathematical model is derived for an underwater plume which would result from convective currents rising from a point heat source located on the bottom of the ocean. A precise derivation of the basic equations for buoyant turbulent jets in the sea is shown. (L.C.L.)

21215 (NYO–3109-31) FOURTH REPORT ON THE "RISING PLUME" PROBLEM IN THE SEA. Okubo, Akira (Johns Hopkins Univ., Baltimore, Md. Chesapeake Bay Inst.). Feb. 1968. Contract AT(30-1)-3109. 19p. Dep. CFSTI.

A mathematical model is derived for an underwater plume which would result from convective currents rising from an extended source (source of finite size) located on the bottom of the ocean. (L.C.L.)

21216 (PRNC–104, pp 118-20) TOPOGRAPHY AND BOTTOM SEDIMENTS OF AN OFFSHORE–ONSHORE TRANSECT, ANASCO BAY. Swift, Donald J. P. (Puerto Rico Nuclear Center, Mayaguez).

The topography and bottom sediments of an offshore–onshore transect in Anasco Bay, Puerto Rico, were studied. The topography was determined to a distance of four nautical miles offshore. The sediment samples were analyzed by sieving and pipetting for percent gravel and sand, and for mean diameter and standard deviation. Percent carbonate was determined by gasometric means. The results are presented. (L.C.L.)

21217 (PRNC-104, pp 121-46) SEDIMENT DISPERSAL PATTERNS AND TRACE ELEMENT DISTRIBUTION, COASTAL WESTERN PUERTO RICO. Swift, Donald J. P. (Puerto Rico Nuclear Center, Mayaguez).

During 1965 and 1966, approximately 170 core and grab samples of sediments from the west coast of Puerto Rico were taken to provide information about sediment distribution, composition, and texture. The results of this study are presented. (L.C.L.)

21218 (PRNC–104, pp 147-66) CLAY MINERALOGY OF BAHIA DE ANASCO, WESTERN PUERTO RICO. Pirie, R. Gordon (Puerto Rico Nuclear Center, Mayaguez).

In June and July 1966, 21 samples of sedimentary deposits from Anasco Bay, Puerto Rico, were collected and analyzed for composition, mineral content, and physical properties. The sampling and analyzing methods are described. The identifiable clay minerals were illite, chlorite, kaolinite, and montmorillonite. For these, it was concluded that: the abundance values vary significantly for most distances from shore; there are no significant variations in clay crystallinity or mineralogy with depth up to 7.5 cm; and a marked increase or decrease in abundance of all clay minerals is noted at approximately 1½ to 2½ km from the shore of Anasco Bay, which corresponds closely to the change in the gradient of the marine bottom topography. (L.C.L.)

21219 EXPLOSIONS DUE TO PRESSURIZED SPHERES AT THE OCEAN SURFACE. Chan, B. C.; Holt, M.; Welsh, R. L. (Univ. of California, Berkeley). Phys. Fluids, 11: 714-22(Apr. 1968).

The effect of an explosion due to the rupture of a pressurized sphere, centered at the ocean surface, is determined. The field of disturbance near the vertical axis through the center of the explosion is determined by Friedman's analytic approach, based on a perturbation of the linear-shock-tube solution. The interaction of the main blast wave with the ocean surface is determined by fitting a locally plane shock with a Prandtl–Meyer expansion, which reduces the shock pressure to atmospheric value. The main object of the calculation is to determine the shape of the distorted ocean surface (or crater). Calculations are made for initial sphere pressures of 619 and 7000 atm, respectively. The shape of the disturbed ocean surface flattens at the base as the strength of the explosion increases, in agreement with the behavior found for intense point source explosions. (auth)

21220 INTENSE EXPLOSIONS AT THE OCEAN SURFACE. Collins, Richard; Holt, Maurice (Univ. of California, Berkeley). Phys. Fluids, 11: 701-13(Apr. 1968).

An approximate solution to the problem of an intense point-source explosion at the interface separating two different fluids is described; in particular, it is applied to a nuclear explosion initiated on the surface of the ocean. Of special interest is the position of the deformed ocean surface as a function of time during the initial phase of the explosion. The equations of motion for an inviscid fluid with no heat conductivity are written in terms of the vertical angle and a similarity variable. The solution is valid for the early phase of the explosion, during which the counterpressure remains insignificant. It is found that the influence of the free surface on the vacuum interface propagated in the water is confined to a 45° sector adjacent to the original free surface. Below this, the vacuum surface retains very nearly its spherical form. This picture of the flow-field form is seen to be in good qualitative agreement with the type of flow fields calculated by Brode and Bjork for a megaton burst on the surface of the earth. (auth)

21221 ON THE CONSTANCY OF DEUTERIUM FRACTIONATION IN THE BIOSYNTHESIS OF FATTY ACIDS SINCE THE MIOCENE PERIOD. Zborowski, G.; Ponticorvo, L.; Rittenberg, D. (Columbia Univ., N. Y.). Proc. Nat. Acad. Sci. U. S., 58: 1660-3(Oct, 1967).

Samples of fatty acids and of amino acids were isolated from a core of the Mohole Project. The deuterium analysis of the fatty acids relative to the water isolated from the core is close to the values found for fatty acids isolated from rats and fish. The presence of unsaturated fatty acids in the lipids suggests an anaerobic environment, at least for the lipids in the core. On the assumption that the deuterium concentration of the Pacific Ocean has not changed appreciably in 10 million years the results indicate that the mechanism for the biosynthesis of fatty acids has not changed in that period. (auth)

21222 STUDIES ON THE ADSORPTION OF RADIOISOTOPES ON MARINE SEDIMENTS. I. ROLE OF EXCHANGEABLE CATIONS ON THE ADSORPTION OF CESIUM AND EXCHANGE EQUILIBRIA. Cheng, Hwa-sheng (Tsing Hua Univ., Taiwan, China); Hamaguchi, Hiroshi. Health Phys., 14: 353-63(Apr. 1968).

The distribution coefficients of cesium in demineralized water and sea water were found to be proportional to the ratio of either exchangeable potassium to total potassium or exchangeable magnesium to total magnesium of the marine sediments. The degree of desorption was, on the contrary, inversely proportional to these ratios. Mass action law could apparently be applied to the Cs–K and Cs–Mg systems, when cesium was employed at tracer concentrations. The observed separation quotients for the two systems were abnormally higher than the equilibrium constants at macroconcentrations. Equilibrium constants increased in the order: Cs–K, Cs–Na, Cs–Mg and Cs–Ca. (auth) (UK)

21223 IODINE ABUNDANCES IN DEEP-SEA SEDIMENTS. Bennett, J. H.; Manuel, O. K. (Univ. of Missouri, Rolla). J. Geophys. Res., 73: 2302-3(Mar. 15, 1968).

The abundance of iodine in deep sea sediments was determined and found to be up to 50 ppM. The iodine appears to be higher than in shales or igneous rocks. Neutron activation analysis was used to distinguish the iodine-128 activity from longer-lived iodine isotopes and from tellurium and uranium. (F.S.)

ENGINEERING

Nuclear Explosions

Refer also to abstracts 21184, 21185, 21187, and 21220.

21224 (HNS-22) GROUND WATER STUDY PROGRAM: PRODUCTION OF LONG-LIVED FISSION PRODUCTS AND THERMAL NEUTRON-INDUCED RADIONUCLIDES IN UNDERGROUND NUCLEAR EXPLOSIONS. Carnahan, C. L.; Kruger, P. (Hazleton-Nuclear Science Corp., Palo Alto, Calif.). Mar. 1, 1963. Contract AT(29-2)-1229. 26p. Dep. CFSTI.

Calculations of initial radioactivity levels are made for long-lived radionuclides produced by fission and thermal neutron activation of the surrounding geologic media resulting from underground nuclear explosions. Since the transport of ground water contaminated with radionuclides is small over short periods of time but may be expected to exist for indefinite time, all radioactive nuclides are considered that have half-lives greater than 0.5 year. Contamination of surface water in the vicinity of a nuclear explosion is not treated. Discussions of the limitations of these calculations also are given. (auth)

21225 (HNS-1229-54) PROCEDURE FOR THE CALCULATION OF NEUTRON ACTIVATION OF AN INFINITE HOMOGENEOUS MEDIUM. Carnahan, C. L. (Hazleton-Nuclear Science Corp., Palo Alto, Calif.). Sept. 15, 1964. Contract AT(29-2)-1229. 62p. Dep. CFSTI.

A method for the calculation of quantities of radionuclides induced in infinite, homogeneous media by neutrons from underground nuclear detonations is developed theoretically and a procedure for practical application of the theory is presented. Results of calculations are given for radionuclides, having half lives greater than 0.5 year, induced by neutrons from fusion reactions and from fission reactions in media having the compositions of the average earth's crust, average carbonate rocks, and the Tatum salt dome, Hattiesburg, Mississippi. Separate calculations are made for fusion neutrons and for fission neutrons because of the great differences in the initial neutron energy distributions and in the total numbers of neutrons produced, per unit energy yield, by the two processes. The following types of reactions are treated: (n,γ), (n,p), (n,α), $(n,2n)$, and (n,np). Secondary reactions and second-order reactions are not considered. Effects due to activation of device and emplacement materials are not considered, and effects due to special neutron-moderating and absorbing materials placed around the device are considered only very superficially. A sample calculation is included. (auth)

21226 (NVO-1229-87) HYDROLOGIC REDISTRIBUTION OF RADIONUCLIDES AROUND A NUCLEAR CRATER. Charnell, R. L.; Fenske, P. R.; Guinasso, N. L. Jr., Schell, W. R.; Zorich, T. M. (Isotopes, Inc., Palo Alto Calif.). July 1967. Contract AT(29-2)-1229. 46p. Dep. CFSTI.

A conceptual model for redistribution of radionuclides around a nuclear excavated crater has been formulated. This model relies on many simplifications to allow analysis of the entire hydrologic system around the crater at the same time. The model is separated in terms of three major regions: fallout zone; ground water zone; and crater rubble zone. The redistribution within each of these sections is treated separately. The entire redistribution of radionuclides is obtained by combining effects from all three sections. The model in its present form is general. It can be applied to many nuclear cratering detonations. The model must be evaluated and refined in terms of a specific cratering application. (auth)

21227 (PNE-1119) AIRBORNE LIDAR OBSERVATIONS, Project Pre-GONDOLA II. Final Report. Collis, R. T. H.; Oblanas, John (Stanford Research Inst., Menlo Park, Calif.). Nov. 1967. 60p. Dep. CFSTI.

Lidar (laser radar) observations from an aircraft of the cloud of debris resulting from the Pre-GONDOLA II explosion at Fort Peck, Montana, are described. With the neodymium (near infrared) lidar pointing horizontally at 45° aft of the aircraft beam, the aircraft made a series of flights past the cloud position at a height of approximately 225 meters above ground level and the lidar was fired at intervals of approximately 6 seconds. Since the cloud rapidly became invisible, these flights were positioned with reference to the lidar observations using a Doppler navigation system. From the lidar observations the location, shape, and internal structure (in terms of variations of density) of the cloud at the flight level were determined at five successive times, extending some 37 minutes after the explosion and some 17 kilometers downwind. While this technique is thus shown to be immediately available (with minor improvements) for limited operational application, the developments necessary to realize its full potential are identified and described. In particular, a significant improvements in the data handling system are proposed. (auth)

21228 (UCID-15259) PURGING OF NUCLEAR CHIMNEYS. Cohen, Jerry J. (California Univ., Livermore. Lawrence Radiation Lab.). Dec. 1967. Contract W-7405-eng-48. 17p. Dep. CFSTI.

Contained underground thermonuclear explosions can result in the retention of large quantities of radioactive gaseous contaminants in the nuclear chimney, notably ^{85}Kr and tritium. Prior to using nuclear chimneys for practical applications such as the storage of natural gas, they must be purged of these contaminants as much as possible. Experiments were conducted using standard aircraft oxygen tanks, either empty or filled with different size sand and gravel to simulate hollow or rubble-filled nuclear chimneys. The void volumes were measured. Purging effectiveness was determined by using ^{85}Kr as a tracer in air, and by measurement of the ^{85}Kr content in the chimney effluent. Two types of purging procedures were tested: continuous purging with clean air injected at the bottom of the tank, and pressure cycling purging (repeated pressurization and depressurization through a single access hole). Results indicated that continuous purging is superior to pressure cycling, and that this can be accomplished with a single access hole by using concentric inlet and exhaust tubing. Larger scale experiments are recommended. (L.C.L.)

Facilities and Equipment

Refer also to abstracts 21227, 21282, 21286, 21297, 21985, 22078, 22079, 22081–22083, 22911–22913, and 22916.

21229 (AD-664118) A FIELD-EXPEDIENT INCINERATOR (PROJECT TEE PEE). Lachapelle, D. G.; Tarbox, J. L.; Maloney, J. C. (Army Nuclear Defense Lab., Edgewood Arsenal, Md.); Bradbury, H. G.; Godbold, N. H.; Miller, W. H. (General Dynamics/Fort Worth, Tex.). Jan. 1968. Contract DA-18-035-AMC-1057(A). 132p. (NDL-TR-98). CFSTI.

An incinerator for expedient concentration of combustible radioactive waste was designed, built, and evaluated. It features portability and ease of assembly. This incinerator (referred to as Tee Pee) employs five oil-fired burners that ignite the waste material and reduce the particulate emission. Four incinerations or "burns" were conducted with rough-cut lumber contaminated with the radioisotope lanthanum-140. The lumber for the burns was prepared as follows: Burn 1–lanthanum-tagged particles ranging from 75 to 150 microns were affixed to the lumber with a dilute lacquer spray; Burn 2–lanthanum-140 in solution was brushed onto the lumber; Burn 3–lanthanum-tagged particles ranging from 20 to 75 microns were "dusted" over the lumber; and Burn 4–lanthanum-140 in solution was brushed onto the lumber. The results of these burns were: 1. average burning rates in excess of 600 lb/hr were achieved, 2. average weight reduction (the ratio of input weight to resultant ash weight) was 115 to 1, and 3. with a variety of simulants and activities, and under the conditions of this experiment, the resultant downwind concentration of airborne contaminant was always below the Maximum Permissible Concentration (MPC) for the isotope used. The conclusion based on these results is that the Tee Pee is a practical device for efficient field-expedient incineration and concentration of combustible radioactive waste. (auth)

21230 (AWRE-O-81/65) INSTALLATION OF HIGH EFFICIENCY FILTERS. Addison, R. A.; Potter, J. E.; Smith, S. E.; White, P. A. F. (Atomic Weapons Research Establishment, Aldermaston (England)). Oct. 1965. 19p. Dep. CFSTI. UK.

A summarized statement is given of the principles which have been evolved over several years at AWRE for the installation of high efficiency air filters in radioactive and toxic process buildings, particularly with respect to the safety aspects of the installations. Details of experimental work carried out have been previously reported. (auth)

21231 (BMwF-FBK-67-68) UNTERSUCHUNG VON STARKEN STOSSWELLEN. STAND: DEZEMBER 1966. (Investigations of Strong Shock-Waves. Status: December 1966). Berge, O. E.; Boetticher, W.; Carls, H.; Dammann, H.; Demmig, F.; Graap, V.; Kleist, G.; Kogelschatz, U.; Manthey, H.; Rehder, L. (Kiel Univ. (West Germany). Institut fuer Experimentalphysik). Mar. 30, 1967. 146p. (In German). Dep.

Experimental investigations of plane (membrane shock tube, $M \leq 15$) and convergent cylindrical shock waves (Z-pinch, $M \leq 100$) are described. Using interferometric methods, an electron precursor of high electron density was found in front of the cylindrical shock fronts. In the shock tube the absolute value of the radiation cooling behind krypton shocks and the ξ-factor of the recombination continuum of krypton were measured. Diagnostic methods (magnetic probes, uv light sources and errors in multiplier measurements) are discussed. The complete set of formulas for an explicit second-order method for solution of quasilinear totally hyperbolic systems of first order with two independent variables is given. (auth)

21232 (CEA-R-3302) "PAGURE": IRRADIATEUR PANORAMIQUE AU ^{60}Co. ("PAGURE": ^{60}Co Panoramic Irradiation Facility). Puig, Jean Rene; Laizier, Jacques; Lorin, Marcel; Laroche, Roger (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires). Nov. 1967. 50p. (In French). Dep.

A description of the various parts of "PAGURE," a 10 kCi panoramic irradiation facility is given. Operational data are also given. After five years of operation, the facility is thought to be very satisfactory. From the point of view of standarization of irradiation facilities, PAGURE can be taken, in its range, as a standard design. (auth)

21233 (K-D-1999) GAS-TURBINE AND DIESEL-DRIVEN VAPOR-COMPRESSION DESALTING PLANTS. Senatore, S. J. (Oak Ridge Gaseous Diffusion Plant, Tenn.); Tomalin, P. G. (Office of Saline Water, Washington, D. C.). [nd]. Contract W-7405-eng-26. 10p. (CONF-680409-1). Dep. CFSTI.

From Western Water and Power Symposium, Los Angeles, Calif.

A study was conducted to determine the economic potential of a gas-turbine or diesel-engine drive for a vapor compressor and a vertical-tube evaporator (VTE) for desalting seawater in 1 to 10-Mgd range. The study employed commercial components for a 2.0-Mgd diesel-driven plant and for a 5.7-Mgd plant with a gas-turbine drive. The diesel-engine and gas-turbine drives for the vapor-compression, VTE concepts have good potential for reducing the cost of seawater distillation in water-only plants. The diesel engines are most effective in the 1- to 5-Mgd range. A third of the original energy of the fuel is supplied to the high-performance-ratio and vertical-tube effects, and over half of the waste heat from the diesel jacket and from the exhaust gases can be recovered in the multistage flash (MSF) evaporator. In the 5- to 10-Mgd range, the gas-turbine-driven concept becomes attractive because of the available units; in this concept, 20 percent of the fuel energy is used in the vertical-tube effects and 56 percent is used in the MSF evaporator. The water cost of the 2.0-Mgd diesel-powered plant with 32¢MBu natural gas fuel is estimated to be 65¢/1000 gallons, based on a fixed charge rate of 5.8 percent. The corresponding water cost for a gas-turbine water-only facility producing 5.7 Mgd is 57¢/1000 gallons. The advantage of the vapor-compression, VTE system is in its economies of about 25 lb product per 1000 Btu fuel without the necessity of using high brine temperatures of very low temperature differences. The engine drive is more economical than an electric drive because the waste heat can be removed effectively. (auth)

21234 (ORNL-TM-2118) SUMMARY OF A DESIGN COMPARISON OF CESIUM AND POTASSIUM AS WORKING FLUIDS IN INTEGRATED RANKINE CYCLE SPACE POWER PLANTS. Fraas, A. P. (Oak Ridge National Lab., Tenn.). Mar. 1968. Contract W-7405-eng-26. 48p. Dep. CFSTI.

The relative advantages and disadvantages of cesium and potassium as working fluids in Rankine cycle space power plants designed for an output of 300 kW(e) are summarized. The design studies, operating experience, and related information available on space power plants were reviewed to provide the basis for a consistent set of design precepts, and using these precepts designs were evolved for the turbine-generator, boiler, condenser, radiator, and pumps. The component designs of the integrated systems that emerged from power plant layout studies included consideration of regenerative feed heating, the use of different types of pump, and system control problems. Cesium gives a substantially smaller, lighter, simpler turbine, but requires a somewhat larger generator and boiler. The combined weight of these three components is about 285 lb lower in the cesium system than in the potassium system. There is little difference in the feed pump weights if a free turbine-driven feed pump is employed. If helical induction electromagnetic pumps are employed, the weight increment associated with the pump and related equipment is about 1657 lb greater for cesium than for potassium. For electromagnetic pumps the system weight for cesium is 7342 lb as compared with 5938 lb for potassium. (auth)

21235 (ORNL-TM-2129) MAGNETIC FIELD COMPENSATION WITH PAIRS OF RECTANGULAR COILS. Silver, Ernest G. (Oak Ridge National Lab., Tenn.). Mar. 1, 1968. Contract W-7405-eng-26. 23p. Dep. CFSTI.

A group of FORTRAN programs is described dealing with the magnetic fields generated by rectangular pairs of current-carrying coils. A program is described for calculating the optimum separation distance between such a pair of coils for producing a field constant to second order at the center of symmetry of the coil pair. A program is described to calculate the currents required to compensate any arbitrary external field at the center of symmetry of any coil pair, and to obtain the resultant field at any point in space due to the external field and three mutually orthogonal pairs of compensating coils. Examples of results are shown. (auth)

21236 (ORO-2980-16) CONTINUOUS, ON-LINE, NUCLEAR ANALYSIS MEASUREMENTS IN PROCESS CONTROL APPLICATIONS. Interim Technical Report No. 4, March 1, 1966–May 31, 1967. Martin, Troy C.; Rhodes, J. R.; Waters, J. B. (Texas Nuclear Corp., Austin). July 31, 1967. Contract AT(40-1)-2980. 88p. Dep. CFSTI.

Research into the applications of nuclear analysis techniques to on-line process control problems has been continued. Modifications to the solids presentation system have increased its versatility in that a much wider variety of different materials, a larger range of particle sizes (up to 1 inch) and a wider range of sample weights and flow rates can now be handled. A closed or open circuit slurry loop has been designed, tested and installed. Using it, aqueous slurries of ores and minerals can be presented continuously to the neutron source and gamma spectrometer. On-stream determination of silicon in taconite (iron ore) has been shown feasible. Materials analyzed include cement raw mix, bauxite, coal, tar sands, copper ore and taconite. Preliminary results show promise for on-line continuous analysis of several of these materials. (auth)

21237 (UUIP-547) A DEMOUNTABLE GLASS CIRCULATION PUMP WITH VARIABLE, HIGH PUMPING SPEED. Gustavsson, John E. (Uppsala Univ. (Sweden). Inst. of Physics). May 1967. 13p. Dep.

A glass circulation pump with a flow rate continuously variable from 0.8 to 8 liters per minute is described. The pressure difference is small, the maximum value being about 16 mm Hg. The pump is used for purification of the counting gas of an ionization chamber with a volume of 600 liters. It is of piston type, and the piston is made of a soft iron tube entirely covered with teflon. The piston is moved by a permanent magnet. The pump is demountable. The stroke length and the stroke frequency are continuously variable. (auth)

21238 (UUIP-562) INFLUENCE OF ADSORBED GASES ON THE EMISSION OF X-RAYS FROM EXPLODING TUNGSTEN WIRES IN VACUUM. Handel, S. K.; Stenerhag, B. (Uppsala Univ. (Sweden). Inst. of Physics). Oct. 1967. 16p. (CONF-671044-2). Dep.

From 4th Conference on the Exploding Wire Phenomenon, Boston, Mass.

Undegassed and degassed tungsten wires, initially coated with a thin impurity layer consisting of tungsten oxide (WO_3) and graphite, have been exploded in vacuum, 2×10^{-6} torr. The 0.1 μF capacitor was discharged at an initial voltage of 20 kV. The loop inductance of the short-circuited system was 150 nH. Correlated measurements of x-ray emission from the "anode side" and dI/dt show that the emission of x-rays starts prior to the shunting discharge. The hard x-ray burst emitted is extremely short (half amplitude width of about 25 nsec) and reproducible both in time and intensity, provided the initial conditions are kept constant. Explosions of undegassed and degassed wires give maximum x-ray photon energies of 23 keV and 11.5 keV, respectively. The dI/dt signals obtained from both kinds of explosions are identical, i.e., the gases initially adsorbed by the wire surface affect the emission of x-rays but not main discharge current. On the other hand, the main discharge current but not the hard x-ray emission is influenced by the impurity layer. Finally, the x-ray output versus the pressure of the surrounding medium has been investigated. It is found that the x-ray burst is reproducible inside the pressure interval 10^{-6} torr to 1×10^{-3} torr. (auth)

21239 MACHINING BERYLLIUM COMPONENTS. EQUIPMENT AND METHODS EMPLOYED BY THE ROYAL ORDNANCE FACTORY, CARDIFF. Green, R. E. Machinery (Engl.), 111: 328-34 (Sept. 27, 1967).

The special machine shop for machining components from Be billets is described. Of windowless construction, the machine shop is supplied with filtered and treated air, and has two systems, of low and high velocity, for the removal of air from machine enclosures carrying poisonous Be dust. Provision is made

for checking the degree of air pollution by Be at regular intervals. Machining methods for Be are generally similar to those for cast iron, and machines employed for heavy cuts, where large amounts of swarf or dust are produced, are provided with complete enclosures. Other machines for drilling, boring and tapping are equipped only with tubing connected to the high-velocity extraction equipment. (auth) (UK)

21240 LES CHAMPS MAGNETIQUES INTENSES, LEUR PRODUCTION ET LEURS APPLICATIONS. Colloques Internationaux, Grenoble, 12–14 Septembre 1966. (Intense Magnetic Fields, their Production and their Applications. International Colloquium, Grenoble, September 12–14, 1966). Colloques Internationaux du Centre National de la Recherche Scientifique No. 166. Paris, Centre National de la Recherche Scientifique, 1967. 437p. (In French and English). (CONF-660921).

Separate abstracts were prepared for 46 of the 50 included papers. The remaining four papers appeared previously in NSA. For abstracts of these see CONF-660921 in the Report Number Index. (M.O.W.)

For abstracts of individual papers see: 21241–21266, 21352–21354, 21392, 21985, 22078–22084, 22132, 22222–22227, and 22494.

21241 HISTORY OF INTENSE MAGNETIC FIELDS AND THEIR CONTRIBUTIONS TO PHYSICS. Bitter, Francis (Massachusetts Inst. of Tech., Cambridge). pp 19-29 of Les Champs Magnetiques Intenses, leur Production et leurs Applications. Paris, Centre National de la Recherche Scientifique, 1967. (In French).

From International Colloquium on Intense Magnetic Fields, their Production and their Applications, Grenoble, France. See CONF-660921.

The following items are discussed: (1) The main types of magnets used in scientific research iron-core magnets, air-core magnets, and pulsed magnets. (2) Their contributions to physics, namely the measurement of magnetic moments of atoms, nuclei, and particles, chiefly finished, and the properties of free electrons in gaseous plasmas and in solids, really only begun. Some of the great landmarks are put into historical perspective. (3) The production of megagauss magnetic fields by implosion, and by capacitor discharge. Some unexplored areas for research with these fields are the deformation of atoms, the study of quantum electrodynamic processes in conjunction with high-energy electrons, as proposed by T. Erber, and finally the production of high pressure under as yet untried conditions. (auth)

21242 HIGH FIELD MAGNETS AT THE NATIONAL MAGNET LABORATORY. Montgomery, D. Bruce (Massachusetts Inst. of Tech., Cambridge). pp 51-9 of Les Champs Magnetiques Intenses, leur Production et leurs Applications. Paris, Centre National de la Recherche Scientifique, 1967.

From International Colloquium on Intense Magnetic Fields, their Production and their Applications, Grenoble, France. See CONF-660921.

The National Magnet Laboratory has more than twenty magnets operating in the 100- to 250-kG range and in the last two years has used over 5000 MWh of magnet time. All the magnets use windings made in the Bitter fashion with plates and insulators stacked to form helices. Below 50 kG, magnets are single coils and utilize fiber-glass reinforced polyamide insulation. Above 150 kG, magnets use multiple concentric coils to limit current density and to allow variation in materials and construction. In this field range coated steel insulators are used to provide structural support and zirconium–copper is generally used above 200 kG. Above 200 kG, the support of stresses is the major problem. The majority of magnets use axial cooling, but the radial cooling has been used in several magnets and offers distinct advantages in long coils and magnets with transverse access. Average current densities of 5×10^4 A/cm^2 have been used with success. (auth)

21243 PHYSICS WITH HIGH MAGNETIC FIELDS AT THE NATIONAL MAGNET LABORATORY. Lax, Benjamin (Massachusetts Inst. of Tech., Cambridge). pp 61-78 of Les Champs Magnetiques Intenses, leur Production et leurs Applications. Paris, Centre National de la Recherche Scientifique, 1967.

From International Colloquium on Intense Magnetic Fields, their Production and their Applications, Grenoble, France. See CONF-660921.

A wide variety of physical phenomena have been studied with magnetic fields in the range of 100 to 200 kG at the National Magnet Laboratory. These investigations have included work in the areas of solid state physics, quantum electronics, plasma physics, spectroscopy, magnetobiology, etc. The greatest attention has been given to the first three. In solid-state physics a number of resonance experiments in the millimeter and far-infrared regions have been performed. Most recently the combination of a cyanide laser, operating at 337 microns, and fields of 150 kG has been utilized to observe cyclotron resonance. Magneto-optical studies in semiconductors and semimetals have revealed further structure at high fields, and the data correlate very well with the more refined energy band theories in these materials. Crossed electric and magnetic fields have been used to investigate photon-assisted magneto-tunneling. Laser emission in semiconductors has been observed in high magnetic fields. The fields reduce the laser threshold substantially and increase the frequency of operation. Recently the use of high power pulsed CO_2 lasers has made it possible to investigate a new class of nonlinear magneto-optical phenomena in which multiphoton resonances have been observed in semiconductors. Transport and magnetic susceptibility phenomena in metals and semiconductors exhibit quantum oscillations at low temperatures and intense magnetic fields. These have been studied by the well-known de Haas–van Alphen and Shubnikov–de Haas effects, as well as by the more exciting new techniques of ultrasonic propagation, magneto-plasma waves, and the optical de Haas–Shubnikov effect at the magnetoplasma edge. The ultrasonic method has been used to investigate the new phenomenon of giant quantum oscillations and also the propagation in Type-II superconductors through the critical transition fields. The helicon Alfvén waves at microwave frequencies and at high fields in semiconductors exhibit large-dimensional and amplitude oscillations. Measurements of critical fields and currents in niobium–tin, vanadium–gallium, and other high field superconductors are key results of the availability of the recently developed magnets capable of achieving fields in excess of 200 kG. The study of Mössbauer effects as a probe for magnetic and nuclear properties is unique at these fields. (auth)

21244 THE FOUR-MEGAWATT INSTALLATION OF THE KAMERLINGH ONNES LABORATORY. Metselaar, J. W.; de Klerk, D. (Kamerlingh Onnes Laboratorium, Leiden). pp 79-82 of Les Champs Magnetiques Intenses, leur Production et leurs Applications. Paris, Centre National de la Recherche Scientifique, 1967.

From International Colloquium on Intense Magnetic Fields, their Production and their Applications, Grenoble, France. See CONF-660921.

The installation consists of four parallel mercury vapor rectifiers with cold cathodes, each supplying 1000 A at 1000 V. At full power, fields up to 80 kOe are obtained in coils of 8.6-cm internal diameter. The coils are wound from rectangular copper wire with cooling slits between the subsequent layers. They are cooled with orthodichlorobenzene, which is circulated through the coil, a heat exchanger and a filter. Special precautions are taken in order to decrease the ripple and the drift in the current and to compensate the influence of irregular variations of the line voltage. (auth)

21245 HIGH-FIELD INSTALLATION OF THE LABORATORIE D'ELECTROSTATIQUE ET DE PHYSIQUE DU METAL: STUDIES OF A COIL. Boissier, R. (Societe Alsthom, Belfort, France); Brichant, F.; Goyer, J.; Fournier, J.; Ricque, R.; Feron, J. L.; Pauthenet, R.; Picoche, J. C. pp 83-90 of Les Champs Magnetiques Intenses, leur Production et leurs Applications. Paris, Centre National de la Recherche Scientifique, 1967. (In French).

From International Colloquium on Intense Magnetic Fields, their Production and their Applications, Grenoble, France. See CONF-660921.

The high magnetic fields installation of the Laboratoire d'Electrostatique et de Physique du Métal is described. The results of studies on a Bitter-type coil are given: The clamping pressure of the plates must be at least 100 kg/cm^2 in order that the effect of contact resistance between two plates to be negligible. The presence of holes involves an increase of 17% of the electrical resistance R of a plate compared to the value R_0 without holes. A general law is given for the variation of the ratio R/R_0 versus the radius of the holes. The temperature difference between the hottest point of the plate and the wall of the cooling channel is about 10°C. Due to the roughness of the cooling channels, the heat exchange coefficient increases by a factor of 2; it is equal to 15 W/cm^2 degree approximately. (auth)

21246 COMBINED SUPERCONDUCTING AND CONVENTIONAL MAGNETS. Wood, Martin F. (Oxford Instrument Co. Ltd.); Montgomery, D. Bruce pp 91-100 of Les Champs Magnetiques Intenses, leur Production et leurs Applications. Paris, Centre National de la Recherche Scientifique, 1967.

From International Colloquium on Intense Magnetic Fields, their Production and their Applications, Grenoble, France. See CONF-660921.

During the last few years the technologies concerned with conventional water-cooled magnets and superconducting magnets have both progressed rapidly. Both types have certain advantages and special fields of application, but in some cases combinations of the two can lead to facilities unattainable by either type alone. Combined systems are examined for the case

of the extension of a 2-MW facility, where the maximum obtainable field can be raised to at least 200 kG, and for the case of the attainment of the highest possible dc field by combining large superconducting magnets and power supplies in the order of 20 MW. In addition design features of an all water-cooled magnet for use beyond 300 kG for the Australian National University in Canberra are described. (auth)

21247 HIGH MAGNETIC FIELDS AND ULTRA LOW TEMPERATURES. Hillier, C. A. E. (Oxford Instrument Co. Ltd.). pp 101-6 of Les Champs Magnetiques Intenses, leur Production et leurs Applications. Paris, Centre National de la Recherche Scientifique, 1967.

From International Colloquium on Intense Magnetic Fields, their Production and their Applications, Grenoble, France. See CONF-660921.

Many aspects of experimental research require the ratio of the magnetic field H, to the absolute temperature T to be as high as possible rather than the absolute values of the two parameters themselves. The reason for this is that the expression e $(-g\beta H/kT)$ appears as the function which determines the relative population of the energy levels of atoms which possess a magnetic moment. The smaller this function is made, the greater the population of the lower levels, and the more ordered is the system under investigation. The areas of research where this is most important are nuclear orientation, optical spectroscopy, and magneto-acoustics. Magnetic cooling, and nuclear cooling also require a high initial value of H/T as the adiabatic temperature change varies directly with H and the lower the initial temperature the lower will be the minimum temperature reached. This paper explains how developments both in refrigeration and magnet technology have made it possible to increase the maximum attainable steady value of H/T by a factor of about 4. This is done by using a Harwell helium 3/helium 4 dilution refrigerator operating at about 0.05°K and an 80,000-gauss superconducting magnet. (auth)

21248 ON THE QUALITY OF THE MAGNETIC FIELD EXCITED BY MERCURY RECTIFIERS. Hirone, Tokutaro (Tohoku Univ., Japan). pp 107-12 of Les Champs Magnetiques Intenses, leur Production et leurs Applications. Paris, Centre National de la Recherche Scientifique, 1967.

From International Colloquium on Intense Magnetic Fields, their Production and their Applications, Grenoble, France. See CONF-660921.

In the case of utilization of mercury vapor rectifier as a source of the dc power for the intense magnetic field, a fairly large pulsation overlaps on the static magnetic field. Also the dc power from the mercury vapor rectifier is liable to be subjected to secular variation. The origins of the pulsation are: (1) the deformation of the voltage wave form in the ac power source; (2) imbalance among the potentials of the three phases in the source of power; and (3) inequality in the characteristics of the rectifier tanks and the slight asymmetry in the circuits. The quality of the static magnetic field in this case was investigated by the present experiment. Preventions for the pulsation and secular variations in the magnetic field produced by mercury vapor rectifiers are discussed in detail. (auth)

21249 A SOLID-STATE RECTIFIER SUPPLY AND HIGH-FIELD SOLENOIDS AT R.R.E. Harris, A. G.; Mulhall, B. E. (Royal Radar Establishment, Malvern, Eng.). pp 113-120 of Les Champs Magnetiques Intenses, leur Production et leurs Applications. Paris, Centre National de la Recherche Scientifique, 1967.

From International Colloquium on Intense Magnetic Fields, their Production and their Applications, Grenoble, France. See CONF-660921.

The development of the high-field laboratory at R.R.E. has included a building extension, the purchase of a 2.5-MW silicon rectifier fed from the public supply to augment the existing 3-MW supply from ex-submarine batteries, and a new design of Bitter solenoid. The reasons for choosing the rectifier rather than rotating machines, and its behavior in the light of limited experience, are discussed. An analysis of the cooling of a Bitter solenoid is presented, which shows that there is an optimum diameter of water flow passage of about 3 mm. Other features of the magnets are briefly described. (auth)

21250 FERROMAGNETIC FLUX CONCENTRATORS IN CONTINUOUSLY OPERATED SOLENOID: OPTIMAL GEOMETRY AND APPLICATIONS. Ruzicka, J.; Litomisky, M. (Nuclear Research Inst., Czechoslovak Academy of Sciences, Rez). pp 121-8 of Les Champs Magnetiques Intenses, leur Production et leurs Applications. Paris, Centre National de la Recherche Scientifique, 1967.

From International Colloquium on Intense Magnetic Fields, their Production and their Applications, Grenoble, France. See CONF-660921.

The arrangement for studying the optimal geometry of ferromagnetic concentrators of magnetic flux in continuously operated solenoid is described. The flux concentrators are used for the current-carrying capacity measurements of the short wire and ribbon samples of high-field superconductors. With respect to the helium dewar dimensions with maximum diameter of commonly used concentrators was 27 mm. The results of the flat and tapered poles measurements are given in diagrams and compared with the theoretical predictions of other authors. In the case of cylindrical flat poles the agreement between the experimental results and theory is about 4%, but for tapered poles the differences reach up to 11%. In comparatively small gaps of tapered concentrators (up to 3 mm) the concentric maximum of magnetic induction (about 6%) was found due to the edge of the cone and the pole face. (auth)

21251 MAGNETIC FIELD USES NEAR $\partial H/\partial a$ MAXIMUM AND NEAR $H\partial H/\partial a$ MAXIMUM. Gaume, F.; Cancade, J. C.; Jaillet, G.; Pourraz, R.; Berthier, P. (Faculte des Sciences, Lyon). pp 129-49 of Les Champs Magnetiques Intenses, leur Production et leurs Applications. Paris, Centre National de la Recherche Scientifique, 1967. (In French).

From International Colloquium on Intense Magnetic Fields, their Production and their Applications, Grenoble, France. See CONF-660921.

Research is reported concerning the obtention of inhomogeneous magnetic fields, having revolution axes, and predetermined topographies. In all cases, the revolution axis is a particular line of the field produced. The calculations, followed in some cases by experimental testing on small models of windings, concerned the following problems: field with uniform gradient in a cylindrical volume; obtention of a high value of the product $H(\partial H/\partial a)$; and uniformization of the product $H(\partial H/\partial a)$ in the neighborhood of its maximum. (M.O.W.)

21252 CRYOGENIC MAGNET SYSTEM FOR QUASI-CONTINUOUS OPERATION. Stevenson, Richard (McGill Univ., Montreal); Marston, Peter. pp 169-74 of Les Champs Magnetiques Intenses, leur Production et leurs Applications. Paris, Centre National de la Recherche Scientifique, 1967.

From International Colloquium on Intense Magnetic Fields, their Production and their Applications, Grenoble, France. See CONF-660921.

The general layout and design of a relatively inexpensive system to produce magnetic fields in the 200- to 300-kOe region is described. The magnets are solenoids wound from high-purity aluminum in a regionalized, stress-reduced configuration. Detailed stress analysis indicates that the solenoids can be built so that the stress in the conductor need not rise above the yield strength of the aluminum. A typical mechanical configuration of a solenoid is described. The coils are cooled by compressed helium gas at about 17°K. The nature of the cooling load determines the mode of operation of the magnets, and the size of the associated cryogenic equipment. (auth)

21253 HIGH MAGNETIC FIELDS VERY CONSTANT DURING 0.1 SECOND. Roeland, L. W.; Muller, F. A.; Gersdorf, R. (Univ., Amsterdam). pp 175-83 of Les Champs Magnetiques Intenses, leur Production et leurs Applications. Paris, Centre National de la Recherche Scientifique, 1967.

From International Colloquium on Intense Magnetic Fields, their Production and their Applications, Grenoble, France. See CONF-660921.

The installation of the University of Amsterdam for generating high magnetic fields consists of an ignition rectifier which is designed so that the output current is controlled by the ignition moments. This rectifier, that can deliver 5.6 MW, is used to generate magnetic fields in a coil which gives the highest field for a given duration of the pulse (0.1 sec or more) and interior diameter: 2 cm. In these fields investigations on conducting samples can be performed. At present a field of 16 MA/m (200,000 Oersted) during 0.3 sec is available. A coil giving 32 MA/m (400,000 Oe) during 0.1 sec is being constructed at this moment. Theoretically, a transient duration of one conduction period is sufficient to remove the ripple with all higher harmonics; however, considering practical problems, a system was decided on that recovers in principle in two conduction periods, with a short additional oscillation in its practical realization. This system is described from the point of view of the theory of the impedance of a piece of transmission line and of the Foster synthesis of such an impedance. (auth)

21254 PICK-UP COIL SYSTEM FOR MEASURING MAGNETIZATION IN HIGH FIELDS. Gersdorf, R.; Muller, F. A.; Roeland, L. W. (Univ., Amsterdam). pp 185-8 of Les Champs Magnetiques Intenses, leur Production et leurs Applications. Paris, Centre National de la Recherche Scientifique, 1967.

From International Colloquium on Intense Magnetic Fields, their Production and their Applications, Grenoble, France. See CONF-660921.

A coil system is described, which allows measurements by induction of small changes of magnetization due to high pulsed magnetic fields. This coil system is highly insensitive to exterior magnetic fields, even if they are inhomogeneous, whereas its sensitivity for a variation of magnetic moment inside the coil is constant over a large part of its volume. Measurements on ferromagnetic metals and alloys are cited. (auth)

21255 NIOBIUM–TIN TAPE FOR THE PRODUCTION OF INTENSE MAGNETIC FIELDS. Benz, M. G. (General Electric Research and Development Center, Schenectady, N. Y.). pp 203-8 of Les Champs Magnetiques Intenses, leur Production et leurs Applications. Paris, Centre National de la Recherche Scientifique, 1967.

From International Colloquium on Intense Magnetic Fields, their Production and their Applications, Grenoble, France. See CONF-660921.

A laminated conductor using diffusion-processed Nb_3Sn, copper, and stainless steel has been developed. This conductor is flexible and has high current density, low normal-state resistivity, and is able to withstand high tensile stress. This type of conductor has been used to fabricate coils in the 10 to 100 kG range. Laminated composite conductors of many sorts can be designed to meet requirements of a variety of conditions. Parameters that can be varied include: width, thickness, current, current density, resistivity (normal state), stability, and strength. (auth)

21256 SUPERCONDUCTIVE-TAPE MAGNET DESIGN ASPECTS. Rosner, Carl H. (General Electric Co., Schenectady, N. Y.). pp 209-13 of Les Champs Magnetiques Intenses, leur Production et leurs Applications. Paris, Centre National de la Recherche Scientifique, 1967.

From International Colloquium on Intense Magnetic Fields, their Production and their Applications, Grenoble, France. See CONF-660921.

Design features that provide for the versatile utilization of composite niobium–tin tapes in high field superconductive magnets are discussed. Based on a pancake module construction concept, edge cooling methods can be used effectively. The diamagnetic behavior of wider superconductive tapes are shown to affect the axial field uniformity pattern so as to cause measurable differences between calculable field profiles based on copper conductors. Combined operation of superconductive magnet and flux pump can be used to compensate for possible losses caused by low resistance joints. A 40 watt superconductive flux pump has been built for operation with 100 kG tape magnets. (auth)

21257 STUDY AND DEVELOPMENT OF HIGH-FIELD COILS AT CENTRE D'ETUDES NUCLEAIRES DE SACLAY. Asesio, P.; Bronca, G.; Florent, R.; Krikorian, J. (CEN, Saclay, France). pp 255-60 of Les Champs Magnetiques Intenses, leur Production et leurs Applications. Paris, Centre National de la Recherche Scientifique, 1967. (In French).

From International Colloquium on Intense Magnetic Fields, their Production and their Applications, Grenoble, France. See CONF-660921.

The following experiments are described: (a) very high fields 10 to 15 T in small volumes: improvements in conventional coils, tests of small superconducting coils, projects of 15-T coils, and experiments with a small-scale 15-T superconducting coil; and (b) 3- to 5-T fields in large volumes: coil with inside diameters varying from 250 to 550 mm; and magnetic field well. (auth)

21258 SUPERCONDUCTING COILS FOR A VERY HOMOGENEOUS FIELD: EXAMPLE OF DEVELOPMENT. Marinet, D. (Centre d'Etudes Cryogeniques, Sassenage, France). pp 289-97 of Les Champs Magnetiques Intenses, leur Production et leurs Applications. Paris, Centre National de la Recherche Scientifique, 1967. (In French).

From International Colloquium on Intense Magnetic Fields, their Production and their Applications, Grenoble, France. See CONF-660921.

Homogeneous field calculations were made for coils of particular forms: groups of solenoids on the same axis with rectangular section. One application of these calculations could be the determination of the size of a coil using the minimum amount of superconducting material and creating a certain field inside a useful volume imposed. A superconducting solenoid of 80 kOe compensated to the sixth order and composing of a practical diameter of 30 mm was constructed. This solenoid consists of two independent (mechanically and electrically) elements compensated separately—inside an element consisting of a niobium–titanium wire which creates a field of 37.5 kOe and outside an element consisting of a niobium–zirconium cable of 7 strands which creates a field of 42.5 kOe. The cryogenic equipment constructed to utilize the coil consists of a helium cryostat of very big capacity and an antidewar which allows one to use the magnetic field at room temperature in a diameter of 15 mm. The group is to be used for nuclear magnetic resonance experiments. (auth)

21259 EXPLOSIVE MEGAGAUSS GENERATORS FOR APPLICATION IN EXPERIMENTAL PHYSICS. Herlach, F.; Knoepfel, H.; Luppi, R.; van Montfoort, J. (EURATOM–CNEN, Frascati, Italy). pp 325-33 of Les Champs Magnetiques Intenses, leur Production et leurs Applications. Paris, Centre National de la Recherche Scientifique, 1967.

From International Colloquium on Intense Magnetic Fields, their Production and their Applications, Grenoble, France. See CONF-660921.

The present experimental situation regarding megagauss magnetic fields produced in explosive-driven flux compression devices is reviewed. Explosive techniques are confronted with conventional methods to produce ultrahigh magnetic fields. Particular attention is given to the problems of the highest achievable fields from the point of view of technical effort as well as of theoretical arguments, the reproducibility of the fields, and the feasibility of physical measurements in these fields. To illustrate the various problems, recent experimental results of the Frascati group are presented. These include different flux compression devices with both cylindrical and plane compression geometry, which generate reproducibly fields of several Megagauss (MG) in volumes of some cm^3, and fields in the sub-megagauss range in large volumes. Design considerations for the devices and measuring problems are discussed, particularly the measurement of the fields with inductive probes and the high-speed photographic techniques. Finally, future developments and applications of the explosive flux compression techniques are discussed. (auth)

21260 THE IIT FLUX COMPRESSION FACILITY. Erber, T.; Forsberg, G. K.; Latal, H. G.; Mazzie, J. A.; Kennedy, J. E. (Illinois Inst. of Tech., Chicago). pp 335-43 of Les Champs Magnetiques Intenses, leur Production et leurs Applications. Paris, Centre National de la Recherche Scientifique, 1967.

From International Colloquium on Intense Magnetic Fields, their Production and their Applications, Grenoble, France. See CONF-660921.

The Department of Physics of Illinois Institute of Technology in conjunction with the Explosives Research Laboratory of IITRI is developing an explosive flux compression facility which will be used in a long term program of investigation of phenomena associated with megagauss fields. One of the principal goals of the research effort is the study of ultrahigh-energy electromagnetic conversion processes in extremely intense magnetic fields; e.g., magnetic bremsstrahlung, radiation reaction, pair production, and nonlinear effects due to vacuum polarization. (auth)

21261 PRODUCTION OF INTENSE MAGNETIC FIELDS BY COMPRESSION WITH AN EXPLOSIVE. Besancon, J. E.; Vedel, J. (CEA, Limeil, France). pp 345-53 of Les Champs Magnetiques Intenses, leur Production et leurs Applications. Paris, Centre National de la Recherche Scientifique, 1967. (In French).

From International Colloquium on Intense Magnetic Fields, their Production and their Applications, Grenoble, France. See CONF-660921.

The high magnetic field generation is obtained by the explosive driven compression of a flux trapped within a conductive liner. The initial magnetic field is generated by the discharge of a 200-kJ condenser bank in 8 turns single-layer coil. This coil induces a 100-kG field inside the stainless steel conductive tube 110-mm long 1.5-mm thick and 90 mm in diameter. The compression time is about 10 μs and the final field of 10 MG is produced in a diameter of 5 mm. The field increases fast in the last microsecond. In order to generate slower increasing field with a flat maximum value, the liner turnaround is worked out. This phenomenon appears when the magnetic pressure exceeds the outside pressure created by the expanding gas. (auth)

21262 2.5 MEGAGAUSS FROM A CAPACITOR DISCHARGE. Forster, D. W.; Martin, J. C. (Atomic Weapons Research Establishment, Aldermaston, Eng.). pp 361-70 of Les Champs Magnetiques Intenses, leur Production et leurs Applications. Paris, Centre National de la Recherche Scientifique, 1967.

From International Colloquium on Intense Magnetic Fields, their Production and their Applications, Grenoble, France. See CONF-660921.

A short program of work has been conducted with two capacitor banks capable of delivering megamp short-circuit currents. The work was completed in April 1965. The aim of the program was to demonstrate the feasibility of generating MG magnetic flux densities in small volumes for times of the order of the microsecond, and hence to achieve energy densities comparable with those obtained by explosives but with a nondestructive system of reasonable repetition rate. With an 11-kJ bank, the maximum field obtained in a volume of about 0.1 cc was 1.5 MG and with a 60-kJ bank, the maximum field in a volume of 0.3 cc was 2.5 MG. The design of the larger bank is described in detail and certain considerations relating to the effects of high fields on the generating coils are discussed. (auth)

21263 DEVELOPMENT OF A 100-kG COIL AND COUPLING TO A PULSE GENERATOR. Rioux, C. (Faculte des Sciences, Orsay, France). pp 373-8 of Les Champs Magnetiques Intenses, leur Production et leurs Applications. Paris, Centre National de la Recherche Scientifique, 1967. (In French).

From International Colloquium on Intense Magnetic Fields, their Production and their Applications, Grenoble, France. See CONF-660921.

With the purpose to realize high magnetic fields in large volumes, a special low impedance coil was built to be coupled to a unipolar, iron-free generator. To obtain a good efficiency and to use the generator at the maximum of its possibilities, the adapted coil has a self-inductance of 0.88 μH, a resistance of 3.5 $\mu\Omega$, and is calculated to generate a field higher than 100 kG in a useful volume of 12 dm^3. Considering the small number of turns of the coil (smaller than two) and the problems of connections to the generator the classical model was rejected. This coil is essentially made of two bulky "half coils" in which cylindrical spiral-shaped slits are cut and filled with insulating material. When a radial current runs in each half-coil, it is deviated by the paddle-shaped conducting sheets, and gets an important azimuthal component which generates the useful magnetic field of the coil. (auth)

21264 INSTALLATION FOR PRODUCTION OF INTENSE PULSED MAGNETIC FIELDS. Van Itterbeek, A.; Van Driessche, W.; De Grave, I.; Myncke, H. (Institut de Basses Temperatures et de Physique Appliquee, Louvain, Belgium). pp 379-83 of Les Champs Magnetiques Intenses, leur Production et leurs Applications. Paris, Centre National de la Recherche Scientifique, 1967. (In French).

From International Colloquium on Intense Magnetic Fields, their Production and their Applications, Grenoble, France. See CONF-660921.

The apparatus of producing pulsed magnetic field of the University of Louvain is based on the discharge of a condensor bank in a coil. The capacity of the condensor bank is 4250 μF and the stored energy is 19 kJ. The obtained field reaches 570 kOe in a volume of 3 cm^3. The mechanical strength of the coils is reinforced by means of a stainless steel cylinder. The change of the characteristics of the field due to the presence of the conducting cylinder was studied. This installation is destined to be used to study the Faraday effect. Some results concerning the paramagnetic ions in an aqueous solution are presented. (auth)

21265 LARGE-VOLUME PULSED FIELD COILS: APPLICATIONS TO SYNCHRONOUS PULSE OPERATION FROM 250 TO 500 kG. Foner, Simon (Massachusetts Inst. of Tech., Cambridge). pp 385-9 of Les Champs Magnetiques Intenses, leur Production et leurs Applications. Paris, Centre National de la Recherche Scientifique, 1967.

From International Colloquium on Intense Magnetic Fields, their Production and their Applications, Grenoble, France. See CONF-660921.

Pulsed field production in excess of the 250 kG dc field currently available at NML is discussed. Large-volume, relatively long-pulse-time coils which can be pulsed at energies of about 100 kJ are described. The largest fields have been attained with solid, machined, helical Be–Cu coils. Typically, a field of 550 kG is attained with a $\frac{3}{4}$-in. ID, 3-in. OD coil with a 500-μs half-period for a discharge of 75 kJ. High-homogeneity, 10-ms pulse time Cu or Be–Cu multilayer solenoids are also described. Typically, a field of 250 kG has been attained with a field uniformity of 1 part in 10^3 over a volume of 7 cm^3. A brief description of the 100-kJ capacitor bank is also given. In order to increase resolution, sensitivity, and feasibility of many pulsed field experiments, synchronous pulse operation is considered. The solid Be–Cu coils appear adequate for 100- to 500-kG field generation if appropriate cooling is available. The system presently planned is capable of dissipating 100 kJ pulsed once per second. The merits of various energy sources for synchronous operation, including the NML dc 10-MW system, direct ac line excitation, and rapidly charged capacitor bank, are discussed and the status of this development is summarized. (auth)

21266 CALCULATIONS FOR AND DEVELOPMENT OF PULSED FIELD COILS. Cros, Y.; Guillot, M.; Pauthenet, R. (Laboratoire d'Electrostatique et de Physique du Metal, Grenoble, France). pp 391-9 of Les Champs Magnetiques Intenses, leur Production et leurs Applications. Paris, Centre National de la Recherche Scientifique, 1967. (In French).

From International Colloquium on Intense Magnetic Fields, their Production and their Applications, Grenoble, France. See CONF-660921.

The apparatus of producing pulsed fields is utilized for the measurement of the magnetizations, at temperatures between 2.6 and 350°K, in strong magnetic fields up to 220,000 Oe. The magnetic field is produced in a solenoid by the discharge of a 3000-V, 2000-μF capacitor storage bank. The coils are of thin-helix type described by S. Foner and H. Kolm; they are constructed of a 2% beryllium–copper alloy. Calculations were made of the pulsed field, taking into account the influence of the skin effect; the latter produces a concentration of current flux toward the axis of the coil; current density at point with the distance r from the axis is not any more than $(1/r)$ as in the case of direct-current system, but $(1/r^n)$ where n lies between 2 and 5 depending on the frequency of the pulsed field; for the coils constructed, n is equal to $\frac{5}{2}$. The influence of principal geometrical factors on the maximum field was studied. Experiments were made on a coil in which the conducting winding is made up of helices of variable thicknesses; for a diameter of 1.8 cm, the maximum field of 255 kOe was attained. (auth)

Heat Transfer and Fluid Flow

Refer also to abstracts 21234, 21284, 21285, 21291, 22705, 22725, 22850, 22873–22875, 22907, and 22910.

21267 (BNWL–632) TESTS OF THE EFFECT OF SCALE BUILD-UP ON HEAT TRANSFER USING UNTREATED WATER UNDER CONDITIONS TYPICAL OF THE ETS-1 EXHAUST DUCT. Dickinson, D. R. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). Mar. 1968. Contract AT(45-1)-1830. 19p. Dep. CFSTI.

The possibility of scale formation in the coolant passages of the NERVA ETS-1 hydrogen exhaust duct was determined by tests conducted in an electrically heated test section representative of one of the flow passages, using well water from Jackass Flats, Nevada. Test conditions were: 1,352,000 Btu/hr ft^2 heat flux and 35 ft/sec water velocity for 243 min; 1,664,000 Btu/hr ft^2 and 35 ft/sec for 110 min; and 159,000 Btu/hr ft^2 and 3.5 ft/sec for 110 min. Little or no rise in wall temperature attributable to scale deposition was observed. Visual inspection at the end of the test showed a clean surface except for a light deposit at the upstream end. No corrosion of the stainless steel tubing occurred. At most, only a slight increase in surface temperature due to scale deposition will occur if untreated water is used to cool the ETS-1 exhaust duct, provided conditions are not more severe than in these tests. (auth)

21268 (ENGG/HT–1) TRANSIENT AND STEADY STATE HEAT TRANSFER THROUGH SPIRAL FINS. Khan, A. Mannan; Butt, Parvez; Iqleem, Javed (Atomic Energy Centre, Lahore (Pakistan). Engineering Div.). July 1964. 53p. Dep.

Heat transfer data are presented for a group of tubes having integral spiral fins. The set of tubes consists of fins ranging from $\frac{13}{16}$ in. pitch to 2 in. pitch and the fin height is kept constant, equal to $\frac{3}{4}$ in. Data have been collected for both steady state and transient state mode of heat transfer. Wherever possible it has been correlated with theoretical calculations. A noval technique of determining thermal conductivity of fin materials was deduced. Effect of pitch variance on mode of heat transfer has been thoroughly studied. (auth)

21269 (EURAEC–1091) PHASE AND VELOCITY DISTRIBUTION IN TWO-PHASE ADIABATIC ANNULAR DISPERSED FLOW. Topical Report No. 18. Alia, P.; Cravarolo, L.; Hassid, A.; Pedrocchi, E. (Centro Informazioni Studi Esperienze, Milan (Italy)). 1966. Contract 060-61-7-RDI. 86p. (EUR–3759; CISE-R–109). Dep. CFSTI.

Work Performed under United States–Euratom Joint Research and Development Program.

In the annular-dispersed regime, the two-phase (gas + liquid) flow can be characterized by two main regions. In the first region (called "core"), located in the central part of the duct, the gas is the continuous phase while the liquid flows in the form of small droplets. In the second region, located close to the wall of the duct, the liquid is the continuous phase. The phase distribution and velocity profiles in this regime, as they have been measured at CISE are discussed. Phase and velocity distribution in the core was determined by means of a probe which could operate either as a Pitot probe or as an isokinetic sampling probe. In the region close to the wall, the flow rates distribution was determined by means of a suitably-shaped isokinetic sampling probe. Thickness data of the "film region" have been also taken through an electrical method. The experiments were carried out at high pressure (up to ~22 kg/cm^2 abs) and room temperature with argon–water and argon–ethyl alcohol mixtures in adiabatic vertical upward flow in circular tubes (1.5 and 2.5 cm ID). The measurements were performed in a position 3.5 m from the mixing section. At this position, the flow was found to be fully (or almost fully, in the case of the highest flow rates) developed. (auth)

21270 (EURAEC-1988) RADIAL TEMPERATURE PROFILE IN A FLUIDIZED-PACKED BED UP TO THE OUTSIDE WALL. Technical Report No. 3. Goossens, W. (Centre d'Etude de l'Energie Nucleaire, Brussels (Belgium)). Nov. 1967. Contracts 006-65-7 RCIB (RD); 016-65-1 RAP B. 27p. (EUR-3786). Dep. CFSTI.

Work Performed under United States-Euratom Joint Research and Development Program.

The importance of the different parameters that influence the heat transfer in radial direction in a fluidized-packed bed is discussed. Data were applied to different situations in this configuration assuming a uniform heat generation, no temperature difference between fixed and fluidized material, no longitudinal temperature gradient and an effective fluidized bed-wall contact area that is twice the area in contact with the packed bed. (auth)

21271 (FFA-113) HEAT TRANSFER IN A TURBULENT BOUNDARY LAYER WITH A PRESSURE GRADIENT NORMAL TO THE FLOW. Thomann, H. (Flygtekniska Forsoksanstalten, Stockholm (Sweden)). July 1967. 22p. Dep.

The effect of a pressure gradient along and normal to the flow direction was investigated experimentally at M = 2.5. On a wall with a stream-wise curvature, the pressure gradient normal to the wall influences the turbulent exchange and thus heat transfer. For the arrangement investigated the boundary layer thickness was about 2 percent of the radius of curvature of the wall. On a concave wall with uniform pressure the heat transfer was increased by about 20 percent and on a convex wall it was decreased by the same amount. If the pressure gradient has a component normal to the flow but in the plane of the wall, it induces a three-dimensional boundary layer. It can also have a marked influence on the heat transfer, increasing it by up to 50 percent. For the present investigation the influence of the pressure gradient in the flow direction is well described by existing theories. (auth)

21272 (LMEC-68-4) EVALUATION OF THE APPLICABILITY OF WATER MODEL TESTING TO LIQUID METAL ENGINEERING PROBLEMS. Bomelburg, H. J. (Atomics International, Canoga Park, Calif. Liquid Metal Engineering Center). Feb. 26, 1968. Contract AT(04-3)-700. 97p. Dep. CFSTI.

The extent to which water model testing can be substituted for liquid metal tests in investigating liquid metal flow problems is examined by applying dimensional analysis. Problems considered are flow through piping systems, pumps, bearings, and fluid seals, flow problems connected with liquid metal heat transfer, cavitation, vortexing, and transients. (auth)

21273 (RT/ING-(67)15) ASPETTI FONDAMENTALI DELL'EBOLLIZIONE. (Fundamental Aspects of Boiling Phenomena). Cumo, M. (Comitato Nazionale per l'Energia Nucleare, Rome (Italy)). 1967. 236p. (In Italian). Dep.

The systematic use of dimensional analysis throughout the various aspects of boiling phenomena supports an organized view in which are inserted experimental results from many laboratories. Whenever possible, well known theoretical proceedings which best explain particular boiling aspects are discussed. (auth)

21274 (SC-RR-67-2996) SPHERE2: A TWO-DIMENSIONAL HEAT CONDUCTION AND TRAJECTORY COMPUTER PROGRAM FOR REENTRY HEATING OF SMALL SPHERICAL BODIES. Watkins, C. B. (Sandia Corp., Albuquerque, N. Mex.). Dec. 1967. 55p. Dep. CFSTI.

The theory and numerical analysis is given for a computer model which treats simultaneously the trajectory and two-dimensional heat transfer for a small reentering sphere. The associated computer program is presented along with instructions for its use. (auth)

21275 (SGAE-RT-13/1967) TEST LENGTHS FOR THE DYNAMICS OF HEAT TRANSFER IN STEAM-WATER MIXTURES. Schmidl, H. (Oesterreichische Studiengesellschaft fuer Atomenergie G.m.b.H., Seibersdorf. Institut fuer Reaktortechnik). [1967]. 16p. (CONF-670912-3). Dep. CFSTI.

From Symposium on the Dynamics of Two Phase Flow, Eindhoven, Netherlands.

A test length for dynamics measurements on single- and two-phase flow is described. It consists mainly of two concentric tubes with 4 and 12 cm dia. The tubes are divided in an input, a middle, and an output section. Only the middle section is instrumented at different places, in order to measure temperature, velocity, pressure and void. The thermocouples and the Pitot gages can be moved in radial direction. The time constants of all instruments are small. The transient response and the transfer function of heat transfer, the radial temperature or velocity distribution and the friction losses at single- and two-phase flow were measured. The void ratio was measured at the input and output of the test length. (auth)

21276 HEAT TRANSFER AND CRITICAL HEAT FLUX IN TRANSIENT BOILING. I. AN EXPERIMENTAL STUDY IN SATURATED POOL BOILING. Tachibana, Fujio; Akiyama, Mamoru; Kawamura, Hiroshi (Tokyo Univ.). J. Nucl. Sci. Technol. (Tokyo), 5: 117-26(Mar. 1968).

Heat transfer and critical heat flux in saturated pool boiling were experimentally studied under transient power condition. The heating elements were flat plates of nickel submerged facing vertically in stagnant water. The heat generation rate in the test section was increased linearly in time, upon which, under certain conditions, the heat flux was found to reach a maximum point located in the nucleate boiling regime. The heat of this critical point increased with mounting sharpness of the transient, and the mechanism that occurs such a high critical heat flux may be the rapid formation and evaporation of thin liquid film at the bases of vapor bubbles. Examination of high speed motion pictures reveals that all bubbles on the heating surface are still in the phase of the first generation until the critical condition is reached. Compared to the case of steady boiling, the effect of differences in the heat capacity of the test section upon the critical heat flux was found to be less marked under the present experimental conditions. (auth)

21277 CALCULATION OF THE STATISTICAL CHARACTERISTIC OF THE STOCHASTIC TEMPERATURE FIELD IN PLATES DURING TURBULENT HEAT EXCHANGE. Bolotin, V. V.; Ibragimov, M. Kh.; Merkulov, V. I.; Moskalenko, V. N. Teplofiz. Vys. Temp., 5: 933-6(Sept.-Oct. 1967). (In Russian).

Experiment has shown that temperature pulsations occur in a conducting wall during turbulent heat transfer. The intensity and spectral composition of the thermal pulsations are determined by the corresponding characteristics of the temperature pulsations in the liquid. These pulsations are of importance in evaluating thermal stresses in metals. An infinite plate having a thickness h is contacted on both sides by turbulent liquid current flows having temperatures T_1 and T_2 which are steady-state, random functions of the coordinates and time. Equations are written for the average temperature T_0 and the average temperature gradient θ along the thickness of the plate. The intensity of temperature pulsations in the wall and the spectral density of the pulsations were calculated for a number of specific cases. Damping of the pulsations takes place faster with a decrease in the heat transfer coefficient and with an increase in the fraction of higher frequencies in the spectrum. A satisfactory agreement between calculated and experimental value was noted for mercury and water. (TTT)

21278 CONVECTIVE HEAT TRANSFER THROUGH LIQUID METALS. Coombs, J. S. (Swansea Univ., Wales); Probert, S. D.; Gibbon, W. M. Chem. Process Eng., 49: 96-102(Mar. 1968).

The state of knowledge of liquid metal heat transfer is reviewed. Topics discussed include the analysis of natural and forced convection, experimental measurements, and wetting. 130 references. (UK)

21279 ANALYSIS OF THE EFFECTS OF VARIOUS PARAMETERS ON THE AVERAGE VOID FRACTIONS IN SUBCOOLED BOILING. Kroeger, P. G.; Zuber, N. (General Electric Co., Schenectady, N. Y.). Int. J. Heat Mass Transfer, 11: 211-33 (Feb. 1968).

An evaluation of the effects of various parameters on the ability to predict accurately the volumetric vapor concentration in subcooled boiling is presented. It is shown that the distribution parameter is of major importance as thermodynamic equilibrium is approached; the point of incipient vapor formation greatly affects the void fraction in the subcooled regime —no reliable method for predicing this point exists; and it appears that the axial temperature distribution is of lesser effect. It is concluded, therefore, that the ability to predict the point of incipient vapor formation is mandatory for accurate prediction of the void fraction in subcooled boiling. Future research should thus be directed towards defining and predicting the location of this point. The results of the analysis also show that the conditions of the heated surface and the introduction of additives may have two effects on the void fraction in subcooled boiling. These effects are discussed and a method for taking them into account is presented. Satisfactory agreement is shown between predicted void fractions and recent experimental data obtained in subcooled boiling of Refrigerant-22 and of water over a wide pressure range. (auth)

21280 METHODS OF STUDYING HEAT TRANSFER IN TRANSITION BOILING. Kovalev, S. A. (High Temperature Research Inst., Moscow). Int. J. Heat Mass Transfer, 11: 279-83(Feb. 1968).

An analysis is presented of stability of transition pool boiling.

Heat transfer is assumed to be stable if after accidental small change in the heating-surface temperature the heat balance of the wall varies in such a way that the initial temperature field begins to recover. For a plate one side of which is in contact with the boiling liquid and the other side with a constant-temperature heat-transfer fluid, the necessary condition for stable heat transfer is obtained. A short description is given of experimental apparatus and methods. Results are presented of the measurements of the heat-flux vs. surface-temperature relation for transition water boiling at atmospheric pressure. (auth)

21281 TURBULENCE SCALE IN CHANNELS FORMED BY CLOSELY PACKED RODS. Kashcheev, V. M.; Nomofilov, E. V. (Inst. of Energy-Physics, Obnisk, USSR). Int. J. Heat Mass Transfer, 11: 267-77(Feb. 1968).

Using Obukhov's method a formula was obtained to calculate turbulence scale distribution in channels formed by closely packed rods arranged in-line or staggered. The functions conformally representing the cross-sections of these channels to the inside of the unit circle, which are necessary for determining turbulence scale, are also presented. (auth)

21282 PHASE AND VELOCITY DISTRIBUTION IN TWO-PHASE ADIABATIC ANNULAR DISPERSED FLOW. Alia, P.; Cravarolo, L.; Hassid, A.; Pedrocchi, E. (CISE, Segrate, Italy). Energ. Nucl. (Milan), 15: 241-54(Apr. 1968).

An experimental study carried out on phase distribution and velocity profiles in two-phase (gas + liquid) upward flow in the so-called annular-dispersed regime is described. Phase and velocity distribution in the core was determined by means of a probe which could operate either as a Pitot probe or as an isokinetic sampling probe. In the region close to the wall, the flow rate distribution was determined by means of a suitably shaped isokinetic sampling probe. Thickness data of the film region have also been measured through an electrical method. The experiments were carried out at high pressure (up to ~22 kg/cm^2 abs.) and room temperature with argon-water and argon-ethyl alcohol mixtures in adiabatic vertical upward flow in circular tubes (1.5 and 2.5 cm ID). The measurements were performed in a position 3.5 m from the mixing section. At this position, the flow was found to be fully (or almost fully, in the case of the highest flow rates) developed. (auth)

21283 X-RAY MEASUREMENT OF VOID DYNAMICS IN BOILING LIQUID METALS. Wentz, L. B.; Neal, L. G.; Wright, R. W. (TRW Systems, Redondo Beach, Calif.). Nucl. Appl., 4: 347-55(May 1968).

X-ray void measurement principles and interpretation are applied to rapid void changes in boiling liquid metals. Measurements on a boiling potassium loop show that millisecond response times are necessary to follow the movement of liquid–vapor interfaces upon nucleation. (auth)

Isotope Technology

Refer also to abstracts 21146, 21228, 21296, and 21399.

21284 (ALO-3633-7(Vol.1)) DEVELOPMENT OF 400 TO 1800°F FIBROUS-TYPE INSULATION FOR RADIOISOTOPE POWER SYSTEMS. PHASE I, FINAL REPORT. VOLUME I. Collins, J. O. (Johns-Manville Research and Engineering Center, Manville, N. J.). Oct. 2, 1967. Contract AT(30-1)-3633. 146p. Dep. CFSTI.

Three MIN-K formulations were developed and evaluated for lead-telluride and silicon-germanium radioisotope thermoelectric generator service. Each formulation has certain optimum characteristics which govern its use, such as intricate service adjacent to lead-telluride elements, bulk load-bearing service to 1400F, or non-load-bearing service to 1800F. All three formulations were designed to have minimum outgassing characteristics. ASTROQUARTZ, DYNAQUARTZ, Irish REFRASIL, and MICROQUARTZ refractory fibers were also found suitable for service adjacent to silicon-germanium thermoelectric elements. Similarly, GLASROCK No. 25, a silica foam, had the best combination of thermal conductivity and compression resistance characteristics of the materials evaluated for load-bearing service at 1800F. (auth)

21285 (ALO-3633-7(Vol.2)) DEVELOPMENT OF 400 TO 1800°F FIBROUS-TYPE INSULATION FOR RADIOISOTOPE POWER SYSTEMS. PHASE I, FINAL REPORT, APPENDIX A. VOLUME 2. Collins, J. O. (Johns-Manville Research and Engineering Center, Manville, N. J.). Oct. 2, 1967. Contract AT(30-1)-3633. 170p. Dep. CFSTI.

Thermoelectric materials (2N, 2P, 3N, and 3P) were exposed to experimental insulation formulations Min-K 1999 and Min-K 2002 in an argon environment at 1000°F for a period of 2000 hours and changes in room temperature resistivity and open circuit voltage were measured at 500 hour intervals. Initial property values were compared with measurements made after each exposure interval and materials in contact with the test insulation material were compared with similar materials separated from the insulation for each exposure condition. Statistical techniques were employed in evaluating the data to the extent that limitations in sample size permitted. A complete compilation of all data is included and each conclusion may be directly traced to basic data. A thorough description of testing techniques and apparatus is also included. (auth)

21286 (AWRE-O-22/68) THE ^{85}Kr LEAK TEST. Murgatroyd, J. L. (Atomic Weapons Research Establishment, Aldermaston (England)). Mar. 1968. 29p. Dep. CFSTI. UK 4s. 6d.

A description is given of the soak procedure and of the operation and calibration of the counting equipment used in the krypton-85 leak test for determining leak rates of evacuated tubes. It is shown that one may detect a minimum air leak rate of 10^{-12} atm cc sec^{-1}, the limit being set by the background radiation. The minimum activity which may be detected unambiguously by the apparatus is about 0.045 μCi. An account is given of the testing and results obtained on two alternative counting systems, calibrated by a typical shell filled with ^{85}Kr to an activity of 0.45 μCi ± 10%, the lowest activity standard available without too great a loss of dispensing accuracy. (auth)

21287 (CEA-R-3204) APPLICATION DE L'ABSORPTION DU RAYONNEMENT γ A L'ETUDE DE LA TEXTURE DES SOLIDES POREUX. (Application of Gamma-Ray Absorption to the Study of the Texture of Porous Solids). Ortega, Miguel (Commissariat a l'Energie Atomique, Grenoble (France). Centre d'Etudes Nucleaires). 1967. 78p. (In French). Dep.

Thesis. Submitted to Univ., Grenoble, France.

A technique which enables the localized measurement of total porosity, open porosity and pore size distribution was developed. The total porosity is calculated from the bulk density. A gamma absorption gage with a ^{137}Cs source is provided. This enables the determination of the density by layers of carbonaceous samples in a practically automatic way. By taking adequate precautions it is possible to obtain the density with a maximum error $\Delta\rho \leq 0.005$ g/cm^3. The open porosity is evaluated by the absorption method after impregnation with bromoform. A new mercury porosimeter is developed using the absorption probe for the measurement of mercury infiltrated into the porous sample. Due to the localized character of exploration by this technique, the variations of porous texture in a heterogeneous sample can be studied. Used as a classical porosimeter, in the case of homogeneous samples, this apparatus is capable of measuring the equivalent diameters of pores between 500 μ and 0.14 μ with a maximum error $\Delta P \leq 0.002$. The facility has the capability of determination of porosities due to macropores combined with the non-limiting character of the method in the field of high pressures differentiates this apparatus from other porosimeters. Examples of utilization of this technique in the case of graphite–gas reactions are presented. (auth)

21288 (EUR-3648) ETUDE DES POSSIBILITES D'APPLICATION DES RADIOISOTOPES A LA DETERMINATION DE LA REPARTITION DES ADJUVANTS SUR LES FILS LORS DE L'ENSIMAGE, DE L'ENCOLLAGE, DU PARAFFINAGE ET DE L'APPRETAGE. Rapport Technique et Rapport Final. (Study of the Possible Applications of Radioisotopes for Determining the Distribution of Adjuvants in Yarns in Oiling, Sizing, Waxing, and Dressing. Technical and Final Reports). Rochas, P.; Pierret, S.; Edel, M.; Gavet, L.; Bouillon, M. (Centre de Recherches de la Soierie et des Industries Textiles, Lyon (France)). Sept. 7, 1967. Contract 025-64-10 IRAF. 60p. (In French). Dep.

The opinion of chemical, textile spinning experts, oil and sizing manufacturers, and experts in the fields of sizing, weaving, and hosiery was solicited in order to find out how radioisotopes are used in the oiling, sizing and application of paraffin to textiles in order to facilitate the work. In the same way, the general distribution of dressing involves unevenness in textile fabric properties. Definitions are given of oiling, dressing, waxing and finishing. A bibliographic study was carried out in order to ascertain the methods developed by various authors for analyzing textile aids. The bibliography is discussed in four sections devoted to oiling, sizing, waxing, and dressing. An analysis of the bibliographical research is provided. Results of the work are given. (auth)

21289 GAMMA METHOD INVESTIGATION OF DENSITY OF LIQUID LEAD, CESIUM, AND GALLIUM. Basin, A. S.; Solov'ev, A. Zh. Prikl. Mekh. Tekh. Fiz., No. 6, 85-7(Nov.-Dec. 1967). (In Russian).

The density of liquid metals was studied using a noncontact

gamma method based on penetrating radiation attenuation by the substance. Descriptions are given of the installation used for studying the density of liquid lead, cesium, and gallium. The tabulated results obtained describe the density of liquid lead by the equation: $\rho_l(Pb) = 10.679$ to 12.887×10^{-4} $(T - 600.6)$ g/cm^3 with the mean square deviation ±0.16%, with a maximum error of ~0.4% for a single measurement at 1320°K; for liquid cesium: $\rho_l(Cs) = 1.8390$ to 5.665×10^{-4} $(T - 301.4)$ g/cm^3 with the mean square deviation of 0.23%, and maximum error of 0.7% at 1120°K; and, for liquid gallium at 1020 to 1400°K $\rho_l(Ga) = 5.63464$ to 5.127×10^{-4} $(T - 1020)$ g/cm^3 with mean square deviation of 0.05% and maximum error of 0.25% at 1400°K. (R.V.J.)

21290 APPLICATIONS OF THE RADIOACTIVE KRYPTON TECHNIQUE IN SCIENCE AND INDUSTRY. Ury, Judith. Atomtech. Tajek., 10: 651-62(1967). (In Hungarian).

Use of radioactive krypton incorporated in solid carriers opened up a new field for the application of tracer techniques for the examination of structural changes. The method, developed primarily by D. Chleck and his collaborators, yielded excellent results in the study of the reactor kinetics of heterogeneous reactions, gas analysis, and investigation of surface phenomena, such as wear of metals and determination of surface deformations. The method is based on the use of "kryptonated" materials, i.e., an organic or inorganic solid into which radioactive ^{85}Kr has been incorporated. The interstitially bound gas is held on the crystal surface at room temperature for several months but mechanical or chemical processes affecting the surface lattice relieves the gas partially or completely. The isotope is an excellent tracer because of its long half-life of 10.6 years and its easily detectable β radiation. The technique has been successfully applied for measuring the surface temperature, determination of rate of wear and corrosion and analysis of the water content of water solvents, such as methanol, and indication of the end point of titrations. (Review article, 23 references). (TTT)

21291 ON METHODS OF MEASUREMENT OF TURBULENT FLOWRATE USING RADIOACTIVE ISOTOPES. Breschi, R.; Notari, A. Calore, 38: 399-402(1967). (In Italian).

The application of radioactive isotopes as tracers in the measurement of flow rates is considered. Three different systems are examined and analyzed. (auth)

21292 ISOTOPE GENERATORS IN WIDESPREAD USE. Elec. Rev., 182: 255(Feb. 16, 1968).

The economics of 4 to 8 RIPPLE isotope thermoelectric generators are discussed, and estimates are made for the larger generators under development. Experience of the use of such generators for marine warning lights is summarized. (UK)

21293 HIGH SILICA MATRIX RADIOACTIVE SOURCE AND METHOD OF PREPARATION. Kivel, Joseph; Manning, Bernard (to Atlantic Research Corp.). U. S. Patent 3,364,148. Filed Aug. 26, 1964.

A source of radioactive energy is prepared by introducing a liquid solution of radioactive material into the pores of a heat-fusible, porous matrix containing at least 92 wt % SiO_2. The solution is forced inwardly into the porous matrix by contacting the matrix with a second liquid free of the radioactive material, evaporating the second liquid and the solvent from the radioactive material, and sealing the radioactive material within the porous matrix by applying heat to the matrix to seal at least the peripheral pores. (Offic. Gaz.) (TSS)

Materials Testing

Refer also to abstracts 22859–22864 and 22893.

21294 (BNWL-CC-763) PRESSURE PIPING CRACK MONITORING DETECTION OF METAL OVERSTRESS BY ACOUSTIC EMISSION. Progress Report, March–June 1966. Hutton, P. H. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). Aug. 2, 1966. Contract AT(45-1)-1830. 32p. Dep. CFSTI.

Results of tests to determine feasibility of monitoring for and locating crack initiation and/or growth in reactor pressure piping by means of transducer initiated acoustic waves are described. Factors discussed include types of transducers and other equipment, acoustic emission signatures, mechanisms of signal propagation, location of origin of acoustic emission in piping, effect of extraneous noise, correlation and evaluation of acoustic emission data. (P.G.C.)

21295 (EUR-3649) ETUDE BIBLIOGRAPHIQUE CONCERNANT LA GAMMAGRAPHIE DU BETON ARME ET PREMIER CAS D'APPLICATION D'UN PONT. (Bibliographical Study Concerning Reinforced Concrete Gammagraphy and the First Practical Application in a Bridge). Settipani, A. (Appareils Gamma Siar, Levallois (France)). Aug. 1, 1967. 48p. (In French). Dep.

The examination of reinforced and prestressed concrete can be performed by nondestructive testing, namely gammagraphy, i.e., the obtaining of plates by means of radioisotopes. The obtaining of internal properties of concrete on films by means of gamma rays (cobalt-60, iridium-192, cesium-137) presupposes the study of a certain number of both physical and x-ray parameters. A bibliographical summary of the publications on this subject by various authors is presented. Information on the parameters of the photographs used, on the possibilities offered by the method, and on practical applications encountered is presented. An examination of a prestressed concrete bridge is described. A number of serious defects have been revealed, such as lack of grouts in the sheathing, cracks in the concrete, parasitic occlusions, absence of tie-wires in the stirrups, incorrect positioning of the reinforcements and heterogeneity in the concrete. The reconstruction of a half beam from the plates affords an overall picture in this case. The development of this process, in conjunction with other nondestructive testing methods enables structures under construction, repair or maintenance to be checked. (auth)

21296 MEASURING EGG SHELL STRENGTH BY BETA BACKSCATTER TECHNIQUE. James, Paul E.; Retzer, Henry J. (USDA-ARS, Beltsville, Md.). Poultry Sci., 46: 1200-3 (Sept. 1967).

A new method, employing β-emitting radionuclides, was developed for determining egg shell thickness and density. Preliminary attempts to measure shell strength by radiation consisted of passing x rays through the egg and measuring their absorption. X rays were found to be absorbed by the contents of the shell as well, and a large-diameter egg had the same effect as a thick shell. This technique was discarded and investigation of the β backscatter technique was undertaken. If an egg shell placed in front of a β emitter is thick and/or dense, it reflects β particles. If it offers little resistance, the particle continues into the egg. Since both thickness and density reflect the β particle, measuring the amount of backscatter indicates more nearly the strength rather than either thickness or density of the shell. Strontium-90 was originally tested as a source because it emits high-energy β particles, is inexpensive, and lasts a long time, but it was considered unsafe to use enough of this material to give an adequate sampling. Ruthenium-106-^{106}Rh was finally chosen as a source. To correlate β backscatter measurements with actual egg shell strength, a measuring device was developed which dropped a steel ball from a height great enough to fracture the egg. A better correlation was obtained with impact resistance than with the thickness of the shell as measured with a micrometer. Ten μCi of activity with counts for 5 sec allowed identification of 6 categories of strength. This provided an extremely sensitive tool, capable of measuring variations in the shell of an individual egg without damaging the egg. The egg remains viable and edible. (BBB)

Protective Structures

Refer to abstract 21503.

Radioactive Material Handling

Refer also to abstract 21229.

21297 (BNWL-677) RESEARCH AND DEVELOPMENT ACTIVITIES FIXATION OF RADIOACTIVE RESIDUES. Quarterly Progress Report, July–October 1967. Platt, A. M. (ed.) (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). Mar. 1968. Contract AT(45-1)-1830. 30p. Dep. CFSTI.

During pot calcination runs PC-4 and PC-5, 650,000 and 1,150,000 Ci of radioactivity were successfully solidified in calcine. This corresponded to 2600 W of self-generating heat in a 12 in. pot for Run PC-4 and 4300 W in the 8 in. pot used for Run PC-5. Temperature differences between the pot centerline and wall were 312 and 495°C, respectively, for the two pots. Heat generation rates ranging from 1.1 to 4.8 kW were measured in five Waste Solidification Engineering Prototypes (WSEP) waste pots. Results were within 90% of estimates based on material balances. The spray solidifier melter furnace, which failed during startup of WSEP Run SS-3, was repaired remotely and successfully tested by heating to 1210°C. Results of work performed in the developmental spray calciner indicate: during continuous melting, PW-2 waste containing excessive flux can foam out of the heated receiver pot as a result of sulfate volatilization; modification of the PW-1 composition may be required to alleviate problems of excessive calciner filter pressure drop; and the use of finely divided $NaPO_3$ as a flux for melting directly in the waste

container increases the corrosion of the container (the total wall corrosion still amounted to only 0.02 in. well within the design allowance of 0.125 in.). Three Glass Melter Condensate treatment methods were studied in detail in order to provide a basis for full level demonstration of treatment methods for a secondary condensate generated in the Phosphate Glass Solidification Process. These methods were sulfate precipitation with barium, calcium, and lead; hydrous oxide scavenging; and volatilization of ruthenium from permanganate treated Glass Melter Condensate. A combination of ruthenium volatilization, hydrous oxide scavenging, and a phosphotungstate precipitation step for cesium removal followed by asphalt incorporation has potential as a highly effective treatment method. (auth)

21298 (DP-1124) INFLUENCE OF HIGH LEVEL WASTE SALTS ON MOVEMENT OF STRONTIUM AND CESIUM IN SAVANNAH RIVER PLANT SOIL. Fenimore, J. W.; Horton, J. H. Jr. (Du Pont de Nemours (E. I.) and Co., Aiken, S. C. Savannah River Lab.). Jan. 1968. Contract AT(07-2)-1. 22p. Dep. CFSTI.

The presence of salts from high level radioactive waste reduced leaching of ^{90}Sr and ^{137}Cs in laboratory columns of sandy clay soil by groundwater and by 0.1N solutions of $Ca(NO_3)_2$, HNO_3, and KNO_3. Waste salts decreased leaching rates by reducing the permeability of waste saturated zones and by increasing ^{137}Cs fixation by mica minerals. (auth)

21299 RECENT DEVELOPMENTS IN AND FUTURE PLANS FOR RADIOACTIVE WASTE MANAGEMENT IN THE UNITED STATES OF AMERICA. Parker, F. L. (Vanderbilt Univ., Nashville). At. Energy Rev., 5: No. 4, 93-121(Dec. 1967).

The fundamental policy and main direction of radioactive waste management in the United States of America is to keep total radiation hazards at or below their present levels although the amount of nuclear power generation will increase exponentially. This level will be maintained through increased emphasis on concentrating, solidifying and containing both high- and low-level wastes and by discharging to the environment a non-hazardous, economically irreducible minimum of radioactive material. There are only six power reactors in the United States on electrical networks that have been operating six months or more with a total capacity of 882 MW(e). Twelve more reactors are at present under construction with a capacity of 7000 to 8169 MW(e), there are under contract 36 reactors of 27,391 to 28,362 MW(e) capacity, and 15 units with 13,191 MW(e) capacity were announced during the first four months of 1967. In view of this increase, releases from nuclear power plants will have to be held to negligible quantities, releases from existing fuel reprocessing sites will have to be or already have been reduced, and new reprocessing plants will have to release far less per unit fuel processed. Means of reaching these goals are described. (auth)

21300 PRESENT STATE AND PROSPECTS OF DEVELOPMENT IN RADIOACTIVE WASTE MANAGEMENT IN THE USSR. Kolychev, B. S.; Sedov, V. M. (State Committee for Utilization of Atomic Energy, Moscow). At. Energy Rev., 5: No. 4, 123-50 (Dec. 1967).

The development of commercial atomic energy, the use of radioisotopes in science, industry and medicine, the use of atomic energy in many types of human activities, in particular, for seawater desalination, depend considerably on the rational and economical solution of the radioactive waste treatment and disposal problem. The significance of this problem is appreciated in the USSR, and attention is therefore paid to the elaboration of new processing methods and the improvement of existing methods. The solution of the radioactive waste management problem in the USSR is based on the following: in the first place, consideration is given to health, and, secondly, economics must be taken into consideration when choosing the proper methods of radioactive waste treatment and disposal; the purified waters should be reused at the plant, if possible; and if the purified water cannot be fully reused, it is necessary to decontaminate the remaining volume to the MPC (maximum permissible concentration) before it is discharged to the environment. By diluting radioactive effluent the total quantity released to the environment remains unchanged although the release concentrations may be acceptable. Research and development are being carried out to improve the liquid waste decontamination, reduce the solid and liquid waste volumes, achieve their safe burial, decrease the operating costs and create new materials and apparatus for radioactive waste processing. Annual and long-term plans for utilization of atomic energy of the USSR for more rapid realization of the research and development work in radioactive waste management are discussed. There are some positive results in the development of new waste treatment methods, in reactor-circuit water purification, in liquid waste injection into deep geological formations, and in design of new facilities. Experiments are being carried out in intermediate- and high-level radioactive waste solidification on an industrial scale, and also in low-level waste decontamination to less than the MPC level. Results of the research and development work have already been published. The results of these studies and some future prospects are summarized. (auth)

21301 TREATMENT OF RADIOACTIVE WASTES IN BULGARIA, CZECHOSLOVAKIA, THE GERMAN DEMOCRATIC REPUBLIC, HUNGARY, POLAND, AND ROMANIA. Malasek, E. (International Atomic Energy Agency, Vienna). At. Energy Rev., 5: No. 4, 151-67(Dec. 1967).

Research work on decontamination and treatment of radioactive waste is directed towards improving existing methods of decontamination, treatment and storage, and also towards the discovery and use of progressive technological processes and new materials giving advantages over those used at present. Methods of increasing the efficiency of decontamination and concentration of radioactivity in the solid phase to reduce the volume of waste and to lower the cost of its treatment and storage are discussed. (auth)

21302 REVIEW OF RADIOACTIVE WASTE MANAGEMENT IN WESTERN EUROPE. Dejonghe, P. (CEN, Mol, Belg.). At. Energy Rev., 5: No. 4, 169-80(Dec. 1967).

Different types of waste treatment used in western Europe are reviewed including low- and intermediate-level waste treatment by chemical flocculation, electrodialysis, evaporation, foam separation, ion exchange and precipitation. Incineration of solid combustible wastes is discussed. Disposal of treated and conditioned waste to the ground, rivers and sea is reported. (F.S.)

21303 MINIMUM THICKNESS OF A WATER-REFLECTED INFINITE SLAB OF AN AQUEOUS SOLUTION OF $^{235}UO_2F_2$ AT OPTIMUM CONCENTRATION. Webster, J. Wallace (Oak Ridge National Lab., Tenn.). Nucl. Sci. Eng., 32: 133-5(Apr. 1968).

The establishment of limiting sizes at optimum uranium concentration in order to define safety standards for the storage, processing, and transport of solutions of fissile materials is discussed. The minimum critical thickness of an infinite slab of uranium-bearing solution is determined. Data are presented on the slab thickness required as a function of slab height. (R.C.K.)

Vacuum Engineering

Refer also to abstracts 21286 and 22509.

21304 (GEPP-21) CONTAMINATION CONTROL IN HIGH VACUUM PROCESSING. Hamilton, H. A. (General Electric Co., St. Petersburg, Fla. Neutron Devices Dept.). Mar. 1, 1968. Contract AT(29-2)-656. 15p. Dep. CFSTI.

Contamination control has a twofold relationship to high vacuum processing. The use of varying levels of vacuum in processing operations represents the most sophisticated current technique for controlling contamination in critical processing. Its use in the vacuum firing mode represents the ultimate in parts cleaning for many applications. Conventional contamination control techniques are an essential foundation for the successful maintenance and operation of vacuum equipment. This paper explores the relationship of conventional contamination control and high vacuum procedures, and develops the potential for the use of these vacuum processes. (auth)

21305 ULTRAHIGH VACUA. Hopkins, B. J. (Univ. of Southampton, Eng.). Contemp. Phys., 9: 115-35(Mar. 1968).

A discussion is given of the need for pressures below 10^{-9} torr and of the developments in the reliable measurement of pressures as low as 10^{-12} torr. The greatest technical change in passing from high to ultrahigh vacua is in materials, since all components exposed to the vacuum have to be baked to at least 300°C. All of the pumps, gages, mass spectrometers, taps and other components described must fulfill this requirement. Examples given for two small ultrahigh vacuum systems in use at Southampton University; one is a getter-ion pumped system in stainless steel, and the other a mercury-diffusion pumped system in glass. (auth)

INSTRUMENTATION

Radiation Detection Instruments

Refer to abstract 22526.

General Detectors and Monitors

Refer also to abstracts 21237, 21376, 22202, and 22553.

21306 (AECL-3023) A SURVEY METER FOR THE MEASUREMENT OF INTENSE γ RADIATION. Jones, A. R. (Atomic Energy of Canada Ltd., Ottawa (Ontario)). Mar. 1968. 11p. Dep. CFSTI. CAN $0.50.

The survey meter can be used for estimating γ-ray dose rates with two linear scales (0 to 3,000 and 0 to 10,000 rads/hour). It is intended for monitoring very high γ-fields in emergencies or, more routinely, intense fields which are quite localized. To provide some protection to the user the detector is at the end of a long extendible probe. The survey meter comprises a silicon junction γ-detector, dc amplifier, and battery monitor circuit. The energy response of the detector permits an estimation of dose to the critical organ for high level exposure. Performance under varying conditions of γ-ray energy and direction as well as temperature is described. (auth)

21307 (AERE-HP/M-139) A SCINTILLATION DETECTOR FOR MONITORING THE X-RADIATION OF ^{239}Pu. Peaple, L. H.; Richards, J. E. (Atomic Energy Research Establishment, Harwell (England)). Sept. 1959. 16p. Dep.

A scintillation detector has been designed to monitor the x radiation from ^{239}Pu. It employs a sodium iodide crystal of dimensions 1.5 in. × 0.2 cm thick and is coupled to a portable survey ratemeter. The detector was required in case it should be necessary to monitor contamination from ^{239}Pu, spread more widely than can be dealt with by conventional laboratory monitoring equipment. A response equal to the background reading is given by a surface concentration of 34 μc/m^2 at 1m. (auth)

21308 (BNWL-SA-1515) COMPTON SUPPRESSION USING PULSE-SHAPE DISCRIMINATION AND ANTICOINCIDENCE TECHNIQUES. Swinth, K. L.; Philipp, L. D.; Hoitink, N. C. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). Mar. 4, 1968. Contract AT(45-1)-1830. 17p. (CONF-680207-3). Dep. CFSTI.

From 11th Scintillation and Semiconductor Counter Symposium, Washington, D. C.

The suppression of the background continuum in solid-state detectors by anticoincidence and/or pulse-shape discrimination aids in the interpretation of spectra and enhances the peak-to-Compton ratio. Studies were performed with both ^{137}Cs and ^{59}Fe sources. For the ^{59}Fe source, an average reduction of 85% in the continuum resulted using a planar diode 110 mm^2 by 2.4 mm deep in an anticoincidence annulus of NaI(Tl). Both the distribution and number of events rejected varied with the amplifier shaping time constants. Results are compared with those obtained by other investigators. (auth)

21309 (CEA-R-3324) EQUIPEMENT DE MESURES DES VEHICULES LEGERS DE SURVEILLANCE ET DE RECONNAISSANCE DE LA S. P. R. CADARACHE. (Measurement Equipment Fitted in Light Vehicles Used for Inspection and Reconnaissance by the Radioprotection Service at Cadarache). Galanti, Antoine; Thirion, Claude; Grandin, Marc (Commissariat a l'Energie Atomique, Cadarache (France). Centre d'Etudes Nucleaires). Dec. 1967. 34p. (In French). Dep.

Normally, these vehicles are used to reinforce the atmospheric supervision network based on four fixed stations. In the case of a planned atmospheric discharge they have to control contamination levels and check that these conform to the scattering forecasts. In the case of accidental atmospheric pollution, their role is to rapidly demarcate the pollution zones and to follow the evolution of this pollution. The main measurements carried out are detection of ambient gamma radiation from 10μrad/hr to 1000 rad/hr, detection of the alpha and gamma contamination, and detection of the beta and gamma contamination of the ground. (auth)

21310 (CEA-R-3403) BANC DE MESURE DE GAZ ACTIFS A DEUX COMPTEURS PROPORTIONNELS. (Measuring System for Active Gases Using Two Proportional Counters). Colomer, Jean (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires). Dec. 1967. 39p. (In French). Dep.

The equipment described is designed for measuring β emitting (^{3}H, ^{85}Kr) radioactive gases of low activity. It has been developed to obtain the best sensitivity: counters with metallic cases operating proportionally with an 80 db amplifier, efficiency close to 100 percent for ^{3}H; and the minimum background noise, by associating two types of protection: absorption of the cosmic and ambient radiation by Pb, and interception by an 8-compartment sheath enclosing each counter. Numerous experimental measurements have been carried out with a view to determining the possible and optimum conditions of operation, including study of CH_4-H_2, CH_4-He, CH_4-A mixtures as filling gases, study of the operation of the counters as a function of the filling pressure of the CH_4, and study of the method of mixing the gases (active gas and counting gas). The mixtures examined proved to be good filling gases. The background noise of the whole system is 0.035 cpm/cm^3 or 0.018 cpm/cm^2 of cathode, making it possible to obtain a detection limit of about 6×10^{-8} μc/cm^3 at N.T.P. The characteristics of the measurement counters in current use are: effective volume, long counter: 135 cm^3, short counter 67 cm^3 approximately, known however to ±0.05 percent; plateau, length, 600 to 800 volts, slope ≤0.5 percent/100 volts, medium at 3,200 volts with CH_4 at 760 torr. (auth)

21311 (CLOR-67/D) DESIGN CRITERIA FOR MOSFET PORTABLE IONIZATION CHAMBER MONITORS. Katkiewicz, W. (Centralne Laboratorium Ochrony Radiologicznej, Warsaw (Poland)). 1967. 32p. Dep.

The parameters of MOSFETs suitable for portable ionization chamber monitors are discussed. The Japanese Hitachi, Nippon, and Mitsubishi are checked in these applications. A portable monitor with ranges 0-3-30-300 mR/h is described. (auth)

21312 (HPR-73) GAMMA THERMOMETER AND NEUTRON DETECTOR APPLICATION. Svanholm, K. (Institutt for Atomenergi, Halden (Norway). OECD Halden Reaktor Prosjekt). Dec. 1967. 33p. Dep.

The paper reports on experience gained with gamma thermometers used as channel power detectors. The gamma thermometer has proved to be a reliable and rugged instrument. An accurate in-pile calibration must be carried out before it can be used directly as a channel power detector. Some tests have also been carried out with self-powered neutron detectors used as channel power detectors. The general merits of these two different types of detectors are described and in particular their behavior respective to control rod disturbance. (auth)

21313 (ISS-67/18) LA RIVELAZIONE DEI NEUTRONI NELLA REAZIONE (e,e'n). (The Neutron Detection in the (e,e'n) Reaction). Campos Venuti, G. (Istituto Superiore di Sanita, Rome (Italy). Laboratori di Fisica). July 3, 1967. 66p. (In Italian). Dep.

A study of neutron detection in (e,e'n) reactions with the ~600 MeV/c electrons extracted from the Frascati Electronsynchrotron, is described. The kinematical conditions, the experimental solutions and the measurements done with a standard counter are discussed. (auth)

21314 (ORNL-4219, pp 30-5) DETECTORS OF IONIZING PARTICLES AND RADIATION. (Oak Ridge National Lab., Tenn.).

Developments outlined include germanium purification, determination of oxygen in germanium, semiconductor resistivity instrumentation, lithium-drifted germanium detectors, cryostats for lithium-drifted diode detectors, basic instrumentation in radioisotope applications, ultraviolet emission from a ^{3}He-Xe gas proportional counter, pressurized ^{3}He gas proportional detector for neutron spectrometry, improved gamma ionization chamber, radioactive gas detector, specifications for G-M tubes, evacuated high-level alpha chamber, and scintillation gamma-ray detector for littoral transport studies, and dual detector positioner. (W.H.K.)

21315 (ORNL-4219, pp 36-46) RADIATION MONITORING. (Oak Ridge National Lab., Tenn.).

A brief description of various facility radiation and contamination alarm systems installed at ORNL is presented. Also, an outline of instruments and components developed include personal radiation monitor-belt, low-level alpha counter, civil defense radiological instruments, engineering assistance and evaluation for the OCD, ion chamber survey meter for civil defense, summary report on civil defense radiological instrument development, gamma monitor and collimator used to investigate an MSRE cell during shutdown, gamma spectrometer and lead

shield for spectral analysis of MSRE cell during shutdown, monitor for alpha emitters in stack effluent, calibration of iodine monitor, portable survey instrument audible device, and linear-log radiation monitor. (W.H.K.)

21316 (RT/EL-(67)13) SISTEMA PER L'ANALISI AUTOMATICA DI FILM DI CAMERE A SCINTILLA. (System for Automatic Analysis of the Film of a Spark Chamber). Pandarese, F.; Spinetti, M. (Comitato Nazionale per l'Energia Nucleare, Rome (Italy)). 1967. 26p. (In Italian). Dep.

A programmed spot scanning system is described using a PDP8 computer on-line to a magnetic deflection CRT. Some examples are given of films scanned by the system with the memory space occupied by the pertinent programs. (auth)

21317 (SC-TM-67-3036) STATISTICAL APPROACH TO HEALTH PHYSICS EQUIPMENT EVALUATION. Stanley, Allen L.; Kaye, George E. (Sandia Corp., Albuquerque, N. Mex.). Mar. 1968. Contract AT(29-1)-789. 23p. Dep. CFSTI.

A brief statistical review is presented and two statistical tests are described that will assist the health physicist in determining proper equipment performance and provide equipment operational history for instrument maintenance personnel. (auth)

21318 (UCRL-50176) DETECTOR HANDBOOK. (California Univ., Livermore. Lawrence Radiation Lab.). Aug. 1967. Contract W-7405-eng-48. 150p. Dep. CFSTI.

Topics discussed include photodiode linearity and saturation data, calibration techniques, fluors and radiators, test light systems, logarithmic detectors, Compton detectors, photomultiplier detectors, photodiode detectors, and solid state detectors. (W.H.K.)

21319 (UUIP-568) OPTICAL PROPERTIES OF SCINTILLATION DETECTORS INVESTIGATED BY MEANS OF A COMPUTER PROGRAM. Falk, F.; Sjoberg, W.; Sparrman, P. (Uppsala Univ. (Sweden). Inst. of Physics). Jan. 1968. 19p. Dep.

A computer program for evaluating the influence of optical parameters on the properties of scintillation detectors (scintillator + lightguide) is described. The detectors considered are cylindrically symmetric. The results of the calculation made for seven differently designed scintillator–lightguide assemblies indicate that the geometrical design and the reflective coating of the scintillator have dominant influence on the performance of the assembly. (auth)

21320 (ORNL-tr-1842) INCREASE OF THE DETECTION EFFICIENCY IN THE USE OF SULFUR AS A FAST NEUTRON DETECTOR. Kadlec, V.; Otopal, P. (Ceskoslovenska Akademie Ved, Rez. Ustav Jaderneho Vyzkumu). Translated from report UJV-1546. 27p. Dep. CFSTI. JCL $2.60 fs, $1.10 mf.

Sulfur activation detector efficiency may be increased by separating the sulfur from the phosphorus-32 by combustion of the sulfur. The effect of the conditions of combustion of sulfur tablets on the yield of ^{32}P, and the losses of radioactive phosphorus are determined (7%). The counting rate of ^{32}P was measured continuously during the fusion and combustion of the tablets. It is concluded that the fast-neutron detection efficiency can be raised by about four orders of magnitude by combustion. (auth)

21321 (ORNL-tr-1843) ABSOLUTE MEASUREMENT OF THE ACTIVITY OF THRESHOLD DETECTORS AND EVALUATION OF THE FAST-NEUTRON FLUX IN THE CORE. Kadlec, V.; Otopal, P.; Vitek, M. (Ceskoslovenska Akademie Ved, Rez. Ustav Jaderneho Vyzkumu). Translated for Oak Ridge National Lab., Tenn., from report UJV-1547. 55p. Dep. CFSTI. JCL $5.60 fs, $1.85 mf.

The absolute fast neutron flux is determined on the assumption that the measurement was made in a spectrum corresponding to the fission spectrum with an energy of 2 MeV. The selected set of detectors which is suitable for measuring the fast neutron spectra [^{103}Rh, ^{115}In, ^{32}S, (or ^{58}Ni), and ^{27}Al (or ^{24}Mg)] is given and their absolute calibration is carried out. All the absolute measurements are based on the absolute measurement of the ^{32}P activity. (auth)

21322 ACCURACY OF VERY-HIGH-ENERGY RADIATION MONITORING. Patterson, H. Wade (Univ. of California, Berkeley). pp 459-71 of Radiation Dose Measurements. Their Purpose, Interpretation, and Required Accuracy in Radiological Protection. Paris, European Nuclear Energy Agency, 1967.

From Symposium on Radiation Dose Measurements, Their Purpose, Interpretation, and Required Accuracy in Radiological Protection, Stockholm. See CONF-670621.

In order to ensure suitable accuracy in health physics measurements of very-high-energy radiation, it is first necessary to lay a proper foundation of knowledge and understanding of the radiation field. This should be done by choosing detectors and analyzing systems that are selective in their response to the radiation of interest and with satisfactory sensitivity. In complex radiation fields, such as those produced by particle accelerators, it is necessary to use several detectors, each with its own range of response and sensitivity. For example, to evaluate the radiation field produced by a proton accelerator of more than 500 MeV energy the neutron energy spectrum must be measured with a series of different detectors whose energy threshold and response as a function of energy are well known. Statistical accuracy in these measurements is based on reducing background in the detection system and controlling its fluctuations. In addition, sensitivity should be such that count rates and signal-to-noise ratios are large. This usually means a large volume or mass of detectors. Experimental accuracy is based on knowing the response of the detector as a function of energy, both as regards selectivity and sensitivity. Experimental parameters and operating conditions of the accelerator should be varied, to check for reasonable variations in detector response. Proper monitors should be used so that data taken at different times can be normalized. Results from different detectors should be compared for consistency and compliance with physical principles. After the radiation field is described in physical terms, i.e., energy spectrum and intensity of each of the components, one can then proceed with some confidence to the use of detectors whose response is ambiguous (rad or rem meters), but which may be of practical use. Shielding for personnel and equipment can be accurately specified, and one can predict the effect of changes in operating conditions of the accelerator. This analytic approach to very-high-energy radiation monitoring requires time and effort, but these are repaid by the accuracy, flexibility and understanding achieved. (auth)

21323 APPLICATION OF PROTON TRACKS AT THE END OF THEIR RANGES IN ILFORD G5 EMULSIONS TO MEASUREMENTS AND CALCULATIONS OF MULTIPLE SCATTERING IN SMALL CELL LENGTHS. Delbrouck-Habaru, J. M.; Baudinet-Robinet, Y. (Univ., Liege). Bull. Soc. Roy. Sci. Liege, 36: 515-21(1967). (In French).

A study of multiple scattering measurements in small cell lengths on proton tracks at the end of their ranges to obtain an experimental value of the scattering constant in these particular conditions is reported. Starting with multiple scattering measurements a method of discrimination between protons, deuterons, and alpha particles when their range is of the order of some hundred microns, that is to say when the constant sagitta method is no more applicable, is described. (auth)

21324 APPLICATION OF INFORMATION THEORY TO PULSED NUCLEAR RADIATION MEASUREMENT. Narita, Masakuni; Ozawa, Yasutomo (Hokkaido Univ., Sapporo). Jap. J. Appl. Phys., 7: 422-6(Apr. 1968).

A new method for pulsed radiation measurements is studied by an application of the information theory of discrete systems. It is derived from entropy concept that in order to measure the photon density with the maximum conversion rate of a counter subjected to pulsed photon beams, the density λ of a Poisson source must satisfy the relation of $\lambda b = \ln 2$ when the resolving time τ of the counter lies between the pulse width b and the period (1/f). Actual devices using feedback circuits for satisfying the above condition are proposed. (auth)

21325 AN IMPROVED CORRECTION FOR EFFECT OF INTERNAL CONVERSION AND GAMMA SENSITIVITY OF β-DETECTORS FOR $4\pi\beta-\gamma$ COINCIDENCE MEASUREMENTS ON ACTIVATED GOLD FOIL. Yamashita, Mikio; Michikawa, Taichi (Electrotechnical Lab., Tokyo). J. Nucl. Sci. Technol. (Tokyo), 4: 378-81(July 1967).

Corrections for the absolute determination of the disintegration rate of activated gold foils using $4\pi\ \beta-\gamma$ coincidence methods are presented. Internal conversion and gamma sensitivity of the beta detector are considered. (W.H.K.)

21326 MULTIPLICATIVE PROCESS IN SEMICONDUCTOR RADIATION DETECTORS. A PRACTICAL APPLICATION OF GOOD'S THEOREM IN THE THEORY OF BRANCHING PROCESSES. Ogawa, Iwao; Furukawa, Masao (Rikkyo Univ., Tokyo). Proc. Cambridge Phil. Soc., 64: 203-14(Jan. 1968).

The electron avalanche that takes place within an internally amplifying semiconductor radiation detector was analyzed statistically, treating the process as an example of multi-dimensional branching processes. By extending the result obtained from Good's theorem to the case of continuous variable, an integral equation is derived for the generating function of the probability that a single primary electron-hole pair, formed at a depth x, induces an avalanche consisting of n pairs. On the basis of this equation, expressions are deduced for the mean value $\bar{n}$ and the standard deviation σ of the total number n of pairs in an avalanche induced by n_0 primary pairs produced at x, as well as the probability $w(x, n_0, n)$ of obtaining an avalanche

of size n. In particular cases these expressions lead to various simple relations of practical importance. (auth)

21327 STUDY OF PROPORTIONAL COUNTER MECHANISMS. Campion, P. J. (National Physical Lab., Teddington, Eng.). Int. J. Appl. Radiat. Isotop., 19: 219-34(Mar. 1968).

In order to examine the operation of proportional counters used for $4\pi\beta$ detectors observations were made on both the electrical pulse and that induced in a photomultiplier which viewed the discharge directly. Measurements on the relative gas gain, the shape of the photon pulse, and the electron transit time are described for methane and 90% argon plus 10% methane gas fillings. At high gas amplifications a marked deviation from the expected exponential gas gain curve is ascribed to self-induced space charge effects, while the general space charge effect is evident at very high counting rates. The optical radiation from the Townsend avalanche is found to give rise to a train of satellite pulses due to the photoelectric effect at the cathode. The photon pulse shape measurements suggest that the development time of a single Townsend avalanche is less than 10 nsec in methane, but varies between about 20 and 50 nsec in argon-methane. The mean life-time of the excited states associated with the optical radiation is of the order of 3 nsec in both gas fillings, although in argon-methane there appears to be an additional component having a considerably longer life-time. The spacing between successive satellite pulses is a measure of the electron transit time across the counter, and under certain conditions in argon-methane this transit time is found to increase as the voltage across the counter is increased. (auth)

21328 CABLE-FEED ELECTRONIC CIRCUIT FOR RADIATION DETECTOR-PROBE. Dukoupil, Stanislav; Polivka, Vaclav Vynalezy, No. 3, 14-15(1966). (In Czech).

A connection circuit for a radiation detector–probe has been introduced, designed primarily for cable-feeding into a high working impedance. The output electrode of the detector-probe is coupled to an integrating capacitor through a bypass capacitor whose capacity matches that of the output electrode. An integrating resistor which is also connected to the capacitor feeds a current amplifier whose input impedance is substantially lower than the integrating resistance and, therefore, the time constant of the response decay is predominantly determined by the RC integrator. Its value is lower than that of the time constant determined by the total capacity of the output electrode of the probe and its working resistance. (tr-auth) (JPRS)

21329 ENERGY CORRELATION IN A MODERATING NON-MULTIPLYING MEDIUM. Turner, W. J. (Australian Atomic Energy Commission, Sutherland, New South Wales). Nucl. Sci. Eng., 32: 139-40(Apr. 1968). (AAEC/TM-397).

It was recently suggested (Trans. Am. Nucl. Soc., 9: 509(1966)) that for a nonmultiplying medium, the detection by removal of neutrons at energy E_1 and time t should show a correlation with detection at a lower energy E_2 at a later time $t + \tau$. It is shown that this conclusion is incorrect and that a correlation can occur only if the detector at E_1 does not remove the detected neutron. (D.C.W.)

21330 BORON-LOADED LIQUID SCINTILLATOR. Thomas, George E. Jr.; Jackson, Harold E. Jr. (to United States Atomic Energy Commission). U. S. Patent 3,372,127. Mar. 5, 1968.

A liquid scintillator that differentiates between radiation due to slow neutrons and γ rays comprises a solvent of either toluene, xylene, mineral oil, or isopropyl biphenyl containing 40 to 50 wt % trimethyl borate and saturated with 9,10-diphenyl anthracene and naphthalene. (AEC)

21331 RADIATION DETECTOR CHARACTERIZED BY ITS MINIMUM SPURIOUS COUNT RATE. Engh, Robert O.; Johnson, Robert G. (to Honeywell Inc.). U. S. Patent 3,344,302. Sept. 26, 1967. Filed Oct. 9, 1964.

A Geiger–Mueller-type detector for ultraviolet radiation which operates at low voltages and has a high current carrying capacity while exhibiting minimal spurious count rates is described. (W.H.K.)

21332 RADIATION DETECTION SYSTEM HAVING WIDE FIELD OF VIEW. Falbel, Gerald (to Barnes Engineering Co.). U. S. Patent 3,348,058. Oct. 17, 1967. Filed Dec. 21, 1964.

The system is composed of a radiation detector mounted on a substrate which is transparent to the radiation being measured; a primary optical means with the detector positioned in its focal plane for applying radiation to the front of the detector; a wide field stop positioned in the focal plane of the primary optical means which defines the system's wide field of view; and a field element, positioned behind the detector for imaging radiation from the wide field of view of the primary optical means which passes the front of the detector, onto the back of the detector. (W.H.K.)

21333 METHOD OF INCREASING THE MAXIMUM OPERATING TEMPERATURE OF A RADIATION DETECTION DEVICE. Mitrofanov, Nicolas (to Kewanee Oil Co.). U. S. Patent 3,342,538. Sept. 19, 1967. Filed June 24, 1966.

A method for increasing the maximum operating temperature of a radiation detection device composed of a chamber and a large-area electrode surface is described. The chamber is filled with a gaseous material having some halogen content, an electric current is passed between the two electrodes causing the halogen gas to be absorbed by the large-area electrode, and then the gas is purged from the chamber. Next, the chamber is refilled with a halogen-containing mixture, and the system is gradually heated, then allowed to cool. The heating and cooling step is repeated at least three times, each time the system is heated to a successively higher temperature. The final temperature is equal to or higher than the desired operating temperature for the device. (W.H.K.)

Nuclear Spectroscopic Instrumentation

21334 (BNWL-MA-41) INSTRUCTION MANUAL FOR MODEL 66-1 COMPACT SINGLE CHANNEL GAMMA SPECTROMETER. Sheen, E. M.; Jackson, C. N.; Busness, K. M. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). Jan. 15, 1967. Contract AT(45-1)-1830. 28p. Dep. CFSTI.

The system is composed of a scintillation probe, regulated high voltage supply, double delay line pulse amplifier, a single channel pulse height analyzer, and a count rate meter. Specifications and operating instructions are presented. (W.H.K.)

21335 (CEA-R-3325) SYSTEME DE COMPRESSION DE BOUFFEES D'IONS POUR LE VAN DE GRAAFF DU CEN CADARACHE. (Compression System for Ion Bursts in the Van de Graaff at the Cadarache Center). Rizzitelli, Lucien; Carossi, Jean-Claude; Calvet, Alain; Arnaud, Andre; Pomelas, Etienne (Commissariat a l'Energie Atomique, Cadarache (France). Centre d'Etudes Nucleaires). Dec. 1967. 34p. (In French). Dep.

Equipment designed for the 5-MeV Van de Graaff which makes it possible to carry out time-of-flight spectrometry experiments is described. A pulsed source produces ion-bursts of controllable width between 10 and 50 msec at a pulse repetition frequency of 3.5 MHz; in each burst the ions are made to follow variable paths so that the particles arrive simultaneously at a pre-selected point. This is achieved by means of a magnet which curves the paths, and at the entrance to which each burst is deflected by two plates which are fed in phase opposition at a frequency of 7 MHz. (auth)

21336 (PINSTECH/PHY-6) FAST NEUTRON TIME OF FLIGHT SPECTROMETER. Malik, Muhammad Yasin; Solaija, Tariq Jamal; Ghani, Abdul (Pakistan Inst. of Nuclear Science and Technology, Islamabad. Nuclear Physics Div.). June 1967. 18p. Dep.

A time of flight spectrometer to be used for the measurement of prompt fission neutron energy spectrum is described. The time resolution of the system has been determined using the coincidence cascade gamma radiations from a ^{60}Co source. A review of the problems associated with the photomultiplier timing is given. The limitations on time resolution of the present set-up are discussed and ways of further improvements are suggested. A time resolution of 3.3 nanosec has been achieved. (auth)

21337 (RISO-168) A PORTABLE γ-SPECTROMETER FOR FIELD USE. Lovborg, L. (Danish Atomic Energy Commission, Risoe. Research Establishment). Oct. 1967. 36p. Dep.

The protable γ-spectrometer described was developed for use in geochemical field work. The pulse-height analyser enters the γ-spectrometer in the form of a separate unit which weighs about 20 kg and is powered from a built-in rechargeable battery. This instrument incorporates high-voltage supply, linear pulse amplifier, single-channel analyser, count rate meter, multidecade scaler, and timer. The equipment also comprises a strip-chart recorder, which, in combination with the pulse-height analyser, permits automatic scanning and recording of spectra in the field. The experience obtained with the equipment in surface and subsurface determinations of uranium and thorium in southern Greenland is described in detail. (auth)

21338 (SC-RR-67-746) TECHNIQUE FOR UNFOLDING NEUTRON SPECTRA FROM ACTIVATION MEASUREMENTS. Greer, C. R.; Halbleib, J. A.; Walker, J. V. (Sandia Corp., Albuquerque, N. Mex.). Dec. 1967. Contract AT(29-1)-789. 99p. Dep. CFSTI.

A technique is presented for solving the Fredholm integral equations describing neutron activation spectroscopy measurements. Through the representation of the spectrum and cross sections as piecewise linear functions of energy, the set of activation integral equations are reduced to a matrix equation.

By introducing a constraint involving a best trial spectrum, it is shown that certain additional physical information usually available to an experimenter can be utilized. Based upon this constraint a unique solution to the matrix equation can be obtained. A computer code incorporating this technique is described. The user has the option of obtaining the closed form exact solution and/or an approximate solution arbitrarily close to the exact solution through an iterative procedure. A rigorous theoretical description of the method is also presented. (auth)

21339 (TID-24308) SPARK CHAMBER NEUTRON SPECTROMETER. Final Report. (Philco-Ford Corp., Palo Alto, Calif. Space and Re-Entry Systems Div.). Dec. 8, 1966. Contract AT(30-1)-3579. 135p. (SRS-TR-3148). Dep. CFSTI.

Design and operation of the spark chamber neutron spectrometer (SCNS) are presented. The SCNS detects neutrons and measures their energy within the 5 to 200 MeV range. Mechanical drawings and electronic schematics are included. (auth)

21340 A METHOD FOR DETERMINING THE INTENSITY OF MONOENERGETIC GAMMA RADIATION IN A COMPLEX SPECTRUM USING A SCINTILLATION GAMMA SPECTROMETER AND ABSORPTION FILTERS. Makaryunas, K. V.; Makaryunene, E. K. (Dept. of Nuclear Physics and Application of Radioactive Isotopes, Vilnyus, USSR). Liet. Fiz. Rinkinys, Liet. TSR Mokslu Akad., Liet. TSR Aukst. Mokyklos, 6: 111-17(1966). (In Russian).

A new, simpler, and more accurate method of investigating gamma-ray spectra is proposed. This method is based on the use of a scintillation gamma-spectrometer in conjunction with appropriate gamma-ray absorption filters. It eliminates the difficulties of measuring the energies of the individual lines against the background noise due to the Compton effect caused by harder radiation. The procedure is as follows: the gamma spectrum is recorded first without a filter and then with a suitable filter, and the difference between the two spectra is plotted. The result is an absorption spectrum of the filter as recorded by the given spectrometer. Since the absorption of the filter and not of the spectrometer is determined, soft radiation can be recorded in the presence of hard radiation using large size scintillators which are more effective. The resultant spectrum has one particular advantage in that the continuous energy level due to the Compton effect is relatively low, so that energies of the individual peaks can be measured. Because of the low noise and good peak resolution, a simpler method for energy calculation can be used which does not require that the response of the spectrometer be known. Advantage is taken of the fact that the peaks closely conform in shape to Gaussian probability distribution curves. Hence, the total shape of the peak can be extrapolated from its apparent shape and the expression describing the Gaussian distribution curve. The area under the curve corresponds to the intensity of a given line. The thickness of the filter should be chosen to reduce statistical errors, and yet allow for the assumption of a single interaction of the gamma quanta with the filter material. For complex spectra a set of several filters may be used. The authors discuss the selection of the filter material and also the precautions taken in setting up the experiments. The proposed method is suitable for investigation of relatively slowly varying gamma-spectra, practically for the whole range of energies which are encountered during the analysis of gamma radiation from radioactive isotopes. (ATD)

21341 THE "SPINNER". A NEW DETECTOR FOR RARE NUCLEAR PROCESSES. Hahn, B. (CERN, Geneva. Univ. of Freiburg i. B.); Spadavecchia, A. Nuovo Cim., 54B: 101-6 (Mar. 11, 1968).

A new type of detector for rare nuclear processes, called "spinner," is described. The principle of the detector consists in producing negative pressures in a liquid by centrifugal forces. The so created metastable state can be destroyed like in the normal bubble chamber by local energy deposition of nuclear particles. The spinner has so far proven to be useful for the determination of spontaneous fission rates and for the detection of very low neutron fluxes. (auth)

21342 THE EFFICIENCY OF ^{6}Li SEMICONDUCTOR SANDWICH SPECTROMETERS IN DIRECTIONAL NEUTRON FLUXES. Silk, M. G. (Atomic Energy Research Establishment, Harwell, Eng.). J. Nucl. Energy, 22: 163-71(Mar. 1968).

The efficiency of lithium-6 spectrometers in neutron beams was calculated by means of a Monte Carlo technique. It is shown that the efficiency is, in general, not very well predicted by earlier calculations based on simpler models. Anisotropy in the lithium-6 neutron reaction is found to be a significant factor in the efficiency calculations, especially at energies below 0.5 MeV. (auth)

21343 SPECTROMETRY OF ALPHA PARTICLES BY N-P COUNTERS BASED ON CADMIUM TELLURIDE. Arkad'eva, E. N.; Maslova, L. V.; Matveev, O. A.; Rud', Yu. V.; Ryvkin, S. M. (Ioffe Inst. of Physics and Tech., Leningrad). Fiz. Tekh. Poluprov., 1: 805-6(1967). (In Russian).

In view of the limitations of the only materials used in semiconductor detectors at the present time (germanium and silicon) data on surface-barrier counters of CdTe n-p junctions are presented. By improving the homogeneity of the material, a resolution of ~1.5% was obtained for alpha particles of 4.8 MeV energy. The initial material was n-type CdTe with carrier density $(2-4) \times 10^{14}$ cm^{-3} and mobility ~500 cm^2/V-sec at 300°K. The crystals were prepared by the method of horizontal zone melting with three temperature regions. The surface-barrier n-p junction was produced by depositing gold on the surface of the crystal. The gold served as the contact for the p-region. Fused indium was used for the n-part of the crystal. Although the material was not very homogeneous, at voltages of approximately 50 V it was possible to obtain an appreciable narrowing down of the spectrum. The signal to noise ratio at 30 V for ^{233}U was ~300. The counters can also be used for γ quanta and β particles. (ATD)

21344 SILICON SURFACE BARRIER DETECTORS FOR X-RAY SPECTROSCOPY. Kalbitzer, S.; Melzer, W.; Stumpfl, W. (Max-Planck-Institut fuer Kernphysik, Heidelberg). Z. Angew. Phys., 24: 181-2(1968). (In German).

From high resistivity n-Si surface barrier detectors of 3 mm thickness were produced. With a dc-coupled Si-FET-preamplifier an electronic resolution of 600 eV FWHM Si was obtained. X rays of 6.4 keV were resolved with 680 eV. The detector and the FET-input stage were cooled with liquid air. (auth)

21345 SCINTILLATION SPECTROMETER FOR THE INVESTIGATION OF ENERGY AND ANGLE DISTRIBUTIONS OF X RADIATION BEHIND DIFFERENT ABSORBERS. Yankelevich, Yu. B. Izv. Tomsk. Politekh. Inst., 138: 49-52(1965). (In Russian).

A scintillation γ spectrometer is described, consisting of an NaI(Tl) crystal, an FEU-24 photomultiplier, a preamplifier, and a pulse-height analyzer (AI-100). The energy resolution of the spectrometer was 8.5% for 630-keV γ quanta and improved to 7% for 1.25-MeV γ quanta. The spectrometer was used to measure the radiation spectra at the output of the RUP-200 commercial x-ray apparatus and the energy spectra of the x radiation behind the different absorbers (steel, aluminum, plastic, etc.) at different angles θ ($0° \leq \theta \leq 180°$). A preliminary reduction of the obtained data confirms the feasibility of flaw detection in materials with the aid of Compton-scattered and coherently-scattered x radiation through different angles. (ATD)

21346 STUDY OF SECTOR-TYPE DOUBLE FOCUSING β-RAY SPECTROMETER USED AS SPECTROGRAPH. Kato, Takeo; Hashizume, Akira (Inst. of Physical and Chemical Research, Tokyo). Rika Gaku Kenkyusho Hokoku, 43: 168-74(Sept. 1967). (In Japanese).

The properties of a sector-type double focusing beta-ray spectrometer ($\rho_0 = 10$ cm) to be used as a spectrograph have been studied. It became clear that the focusing points of the electrons lie on a straight line within a limited momentum region. This region covers the momentum range from $-0.05\,P_0$ to $0.03\,P_0$, where P_0 is the momentum of electrons on the optical axis. Thus the K and L lines of the conversion electrons can be measured at the same time by using a photographic plate or a position counter. (auth) (NSA of Japan)

High Energy Physics Instrumentation

21347 (AD-666080) SPARK SPECTROMETER FOR HIGH ENERGY PARTICLES. Takibaev, Zh. S. Translated by J. Stock from Vestn. Akad. Nauk Kaz. SSR, 22: No. 8, 3-9(1965). 16p. (FTD-HT-23-743-67). CFSTI.

After reviewing the difficulties involved in determining the energy of high-energy particles (>10^{11} eV) from track curvatures with ionization chambers, movable films, and other methods, a spectrometer design is proposed consisting of several spark chambers, Fe absorbers, and scintillators. The use and operation of the spectrometer are discussed in extensive detail. Also, variations in configuration are proposed: e.g., one in which spark chambers, scintillators, and Fe absorbers are alternated in a stack. In this design the plastic scintillators or the vessels containing the scintillation liquid have a special shape to compensate for the emitted light with respect to the photomultipliers. (auth)

21348 (CEA-R-3357) UN APPAREILLAGE ELECTRONIQUE DESTINE A LA MESURE DU PARAMETRE DE POLARISATION DANS LA REACTION D'ECHANGE DE CHARGE $\pi^- p \rightarrow \pi^0 n$ SUR CIBLE DE PROTONS POLARISES. (Electronic Device for Measuring the Polarization Parameter in the $\pi^- p \rightarrow \pi^0 n$ Charge Ex-

change Reaction on a Polarized Proton Target). Brehin, Serge (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires). Dec. 1967. 77p. (In French). Dep.

Thesis.

An electronic apparatus was constructed to measure the polarization parameter $P_0(t)$ in $\pi^-p \rightarrow \pi^0n$ charge exchange scattering at 5.9 and 11.2 GeV/c on a polarized proton target. This device insures triggering of a heavy plate spark chamber, allowing visualization of γ rays from the π^0 decays when the associated neutron offers suitable characteristics in direction and energy. The neutron is detected by an array of 32 counters and its energy is measured by a time of flight method. Electronic circuits of this apparatus are described as test and calibration methods used. (auth)

21349 (CONF-670923–, pp 556-70) SPECTROMETERS AND THEIR SPECIFICATIONS. Wilson, Richard (Harvard Univ., Cambridge, Mass.).

Spectrometers and factors in the choice of an appropriate spectrometer are considered. The spectrometer types discussed are the hodoscopic, focusing, sloped-window, spectrometers in coincidence, and special spectrometers. (J.F.P.)

21350 (CONF-670923–, pp 571-85) STREAMER CHAMBERS. Mozley, R. (Stanford Linear Accelerator Center, Calif.).

In the discussion of streamer chambers the main emphasis is placed on their description with respect to their actual use in physics experiments. The principle of operation of streamer chambers is also briefly reviewed. A helium-filled chamber used as an analyzer of nuclear polarization and an Ne–He filled chamber used to analyze K_2^0 decay into $\pi^+ + \pi^- + \pi^0$ are discussed. (J.F.P.)

21351 (ORO-2504-116) SUMX VERSION M-4. Technical Report No. 763. Glasser, R. G. (Maryland Univ., College Park. Dept. of Physics and Astronomy). Dec. 1967. Contract AT(40-1)-2504. 29p. Dep. CFSTI.

SUMX is a computer program used to summarize and manipulate data. A description of the version of SUMX currently in use at the University of Maryland for analyzing the final physically relevant data from bubble chamber data analysis programs is presented. The program is written in FORTRAN IV. It has run on the Univac 1108 under FORTRAN V and on the IBM 7094 under IBSYS. (W.H.K.)

21352 INTENSE MAGNETIC FIELDS AND NUCLEAR PHYSICS. Florent, R. (CEN, Saclay, France). pp 247-53 of Les Champs Magnetiques Intenses, leur Production et leurs Applications. Paris, Centre National de la Recherche Scientifique, 1967. (In French).

From International Colloquium on Intense Magnetic Fields, their Production and their Applications, Grenoble, France. See CONF-660921.

It is shown how magnetic fields are important in nuclear physics and outlines the interest of increasing its value, specially by using superconducting materials. Some applications are given: very large hydrogen bubble chamber, coils for polarized proton targets, experience with short-lived particles. (auth)

21353 STUDIES ON HIGH MAGNETIC FIELD PROJECTS BY THE LABORATORIE DE PHYSIQUE CORPUSCULAIRE DE STRASBOURG–CRONENBOURG FOR EXPERIMENTS PERFORMED WITH NUCLEAR EMULSIONS. Massue, J. P.; Royer, J.; Eberle, H. (Laboratoire de Physique Corpusculaire, Strasbourg–Cronenbourg, France). pp 299-301 of Les Champs Magnetiques Intenses, leur Production et leurs Applications. Paris, Centre National de la Recherche Scientifique, 1967. (In French).

From International Colloquium on Intense Magnetic Fields, their Production and their Applications, Grenoble, France. See CONF-660921.

In experiments of high-energy physics using nuclear emulsion, utilization of high magnetic field is very important to determine charge moment, and mass of the particles. An experiment was undertaken using a 45-kG superconducting magnet with niobium–zirconium, a 106-kG pulsed magnet coil, and 540-kG pulsed magnet coils. (auth)

21354 EXPERIMENTS WITH A BUBBLE CHAMBER IN FAST PULSED FIELDS OF UP TO 225 kG. Bergmann, W. H. (Max-Planck-Institute for Physics, Munich). pp 371-2 of Les Champs Magnetiques Intenses, leur Production et leurs Applications. Paris, Centre National de la Recherche Scientifique, 1967.

From International Colloquium on Intense Magnetic Fields, their Production and their Applications, Grenoble, France. See CONF-660921.

A pulsed field coil, 100-mm length, 70-mm diameter, associated with a bubble chamber which provides at its center a 225-kG field is described. The thickness of the coil is such that it corresponds to a quarter of the wave length of the electrodynamical shock waves, in order to support the mechanical strains (10 t/cm^2). The experimental conditions are described. (auth)

Radiation Dosimeters

Refer also to abstracts 21515 and 21534.

21355 (AAEC/TM-412) LITHIUM FLUORIDE THERMOLUMINESCENT DOSIMETRY DEVELOPMENT. Robertson, M. K. (Australian Atomic Energy Commission Research Establishment, Lucas Heights). Oct. 1967. 13p. Dep.

A lithium fluoride dosimetry system, able to detect down to 10 mR of gamma radiation, has been developed through several stages as deficiencies in the system have been eliminated. Troublesome features in the design of such a system are emphasized. The final system employs 50 mg of LiF (TLD) powder compacted between inert chromic oxide filler in an evacuated glass envelope. Sample heating is accomplished with an internal nichrome filament. Because of the inflexibility associated with a sealed system this dosimeter is more suitable for routine measurements than for general laboratory use. (auth)

21356 (CEA-R-3376) SUR LA MESURE ET L'ANALYSE DES RAYONNEMENTS DE HAUTE ENERGIE PAR DETECTEURS A ACTIVATION. APPLICATION A LA DOSIMETRIE. (Measurement and Analysis of High-Energy Radiation Through Activation Detectors. Application in Dosimetry). Sklavenitis, Laodamas (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires). Jan. 1968. 141p. (In French). Dep.

Thesis. Submitted to Faculte des Sciences, Univ. of Toulouse, France.

Measurement and analysis of radiation fluences within objects of small volume submitted to a high energy proton beam are studied. A detailed study of the radiation nature and energy spectra as well as of the various dosimetry methods is presented. In order to select a group of detectors, high energy nuclear reactions were systematically studied and for some of them cross sections were measured or calculated: for example the cross section of the reaction $^{11}B(p,n)^{11}C$ between 150 and 3,000 MeV and of the reaction $^{34}S(p,2pn)^{32}P$ between 50 and 3,000 MeV. The second part is relative to the application of the aforementioned analysis to radiation within a tissue equivalent phantom irradiated by 3-GeV protons. This analysis is sufficiently detailed to allow the reconstitution of the absorbed doses, the dose equivalent and, contingent on a better knowledge of the dose due to heavy particles, the quality factors. It allows also to follow the evolution of the various dosimetric data as a function of the depth inside the phantom and to verify calculations already done by other researchers. The comparison of the measured doses and the corresponding detector activities shows that some detectors could give directly the absorbed dose, or even the dose equivalent, by a simple activity measurement. (auth)

21357 (COO-1105-129) THERMOLUMINESCENT RESPONSE OF LITHIUM FLUORIDE TO RADIATIONS WITH DIFFERENT LET. Suntharalingam, Nagalingam (Wisconsin Univ., Madison). 1967. Contract AT(11-1)-1105. 119p. Dep. CFSTI.

Thesis.

The supralinear response of lithium fluoride thermoluminescent dosimeters to 50-keV to 33-MeV electrons, 662-keV gamma rays, thermal neutrons, 4.44-MeV deuterons, and soft x rays is investigated in detail. It is concluded that there are four different radiation quality dependent effects in the thermoluminescence of lithium fluoride: the usual low energy increase in photoelectric cross section, the decrease in supralinearity with increase in LET, the decrease in the response of sensitized phosphor with increase in LET, and the increase in efficiency at low doses with increase in LET. A physical model for the supralinearity is proposed. The changes in sensitivity are accounted for by the elimination of competing mechanisms during irradiation. (W.H.K.)

21358 (ORNL-TM-2120) NEUTRON-ENERGY THRESHOLD DETECTOR SYSTEM EMPLOYING SOLID-STATE NUCLEAR TRACK DETECTOR AND FISSILE RADIATOR UNITS. Kerr, G. D. (Oak Ridge National Lab., Tenn.). Mar. 1968. Contract W-7405-eng-26. 21p. Dep. CFSTI.

Improvements have been made in threshold detector systems used for measurement of neutron fluence and dose by the application of solid-state nuclear track detector–fissile radiator units. Fission fragment tracks in the detectors are exposed by chemical etch and viewed with an optical microscope. Detection efficiencies for these units, techniques for evaluation of Lexan nuclear track detectors, and data used in fluence and dose calculations are given. Absorbed doses in a small sample of tissue from a fast fission spectrum of neutrons can be measured over a range of 1 to 10^4 rads with ^{239}Pu, ^{237}Np, and ^{238}U fissile radiators of 30, 50, and 30 μg/cm^2, respectively. Comparisons with conventional

threshold detector systems under a variety of exposure conditions have given agreement to within 10%. (auth)

21359 (AD-663930) DOSIMETRY OF IONIZING RADIATIONS. Ivanov, V. I. Translated from pp 1-263 of Dozimetriya Ioniziruyushchikh Izluchenii, Atomizdat, Moscow, 1964. 260p. (FTD-MT-65-160). CFSTI.

The training aid is written on the basis of a course of lectures read by the author at the Moscow Engineering-Physics Institute, and is designed for a reader familiar with atomic and nuclear physics, methods of registration of radiation, and interaction of radiation with substance. The book sets forth physical bases and calculation and experimental methods of dosimetry in conformity with effective training programs. The aid is intended for students specializing in the area of physics of shielding and dosimetry. The book will be useful to engineers, technicians, and laboratory assistants, practically studying questions of the dosimetry of nuclear radiations. (auth)

21360 (N-67-26397) LUMINESCENT DOSIMETRY OF HARD RADIATION. LABORATORY DOSIMETER. Arkhangel'skaya, V. A.; Razumova, T. K. Translated for Lockheed Missiles and Space Co., Palo Alto, Calif., from Opt.-Mekh. Prom., No. 2, 16-20(1967). 7p. CFSTI.

Described is a portable laboratory dosimeter that uses thermoluminescent phosphor as detector of ionizing radiation and records the light flux emitted by the excited dosimeters photoelectrically. Analyses of various luminescent materials showed that crystal phosphors on $CaSO_4$ and CaF_2 base, activated by Mn, are most suitable for luminophor detectors. Dosimeter constructions are presented for the measurements of external, inter-cavity, and intra-muscular gamma exposure. (STAR)

21361 NEUTRON PERSONNEL DOSIMETRY BY NON-PHOTOGRAPHIC NUCLEAR TRACK REGISTRATION. Becker, K. (Juelich Nuclear Research Establishment, Ger.). pp 317-41 of Radiation Dose Measurements. Their Purpose, Interpretation, and Required Accuracy in Radiological Protection. Paris, European Nuclear Energy Agency, 1967.

From Symposium on Radiation Dose Measurements, Their Purpose, Interpretation, and Required Accuracy in Radiological Protection, Stockholm. See CONF-670621.

The recently discovered method of nonphotographic nuclear track visualization by etching of the surface of insulators can be used for thermal and fast neutron dosimetry by: (n,f) reactions (fission fragment registration in glasses, mica, or plastics); (n,α) reactions (alpha particle registration in alpha sensitive plastics); and registration of recoil nuclei. Neutron energy distributions can be measured by using additional absorbers and/or threshold reactions. The method is superior to nuclear emulsion techniques in many respects, such as sensitivity; dose range; directional dependence; insensitivity against x, γ, and β radiation, and disturbing environmental influences; fading stability; and fast and simple evaluation. The etch pit counting in the optical microscope can be avoided by several optical or electrical methods. Some aspects of the practical application of this technique in personnel routine and emergency dosimetry and examples of special applications (biomedical research, dE/dx spectroscopy, urinalysis) are briefly discussed. (auth)

21362 DETERMINATION AND ACCURACY OF RESULTS OF REM-COUNTER MEASUREMENTS. Nachtigall, D. (EURATOM, Geel, Belgium). pp 391-413 of Radiation Dose Measurements. Their Purpose, Interpretation, and Required Accuracy in Radiological Protection. Paris, European Nuclear Energy Agency, 1967.

From Symposium on Radiation Dose Measurements, Their Purpose, Interpretation, and Required Accuracy in Radiological Protection, Stockholm. See CONF-670621.

The term rem-counter is normally used for a neutron measuring instrument whose sensitivity per unit neutron fluence is believed to be inversely proportional to ICRP values giving the relation of dose equivalent to the neutron energies. The reading of such an instrument is assumed to be proportional to the maximum dose rate equivalent in a human body, regardless of the neutron energy spectrum in the range of practical interest, i.e., thermal energy to about 10 MeV. Rem-counters contain a detector for thermal neutrons covered by a moderator layer. The construction, application, determination of the dose rate equivalent, sensitivity curves, calibration problems and accuracy of the different types of rem-counters and rem-counter measurements are discussed. The main source of uncertainty results from the lack of suitable mono-energetic neutron sources for calibration in the intermediate energy range. (auth)

21363 PRECISION AND LIMITS OF THE DOSIMETRY BY PASSIVE DOSIMETERS IN THE CASE OF INTENSE AND COMPLEX RADIATIONS. Bricka, M.; Lavie, J. M. (Commissariat a l'Energie Atomique, Paris). pp 425-34 of Radiation Dose Measurements. Their Purpose, Interpretation, and Required Accuracy in Radiological Protection. Paris, European Nuclear Energy Agency, 1967. (In French).

From Symposium on Radiation Dose Measurements, Their Purpose, Interpretation, and Required Accuracy in Radiological Protection, Stockholm. See CONF-670621.

Passive dosimeters, such as activation detectors for neutrons, and glass and thermoluminescent detectors for gamma radiation can normally only be used for large radiation fields. Their use is particularly interesting in this sphere, which generally covers incidents involving serious hazards for individuals: their sensitivity is then adequate and they require no maintenance. Experiments have shown that an accuracy in the region of 10% can be expected for the measurement of flux. It is more difficult to quote a figure for accuracy when measuring radiation doses, in view of the complexity of the interaction between radiation and the body system. Damage should perhaps be linked directly with the physical measurement of the radiation received, in the same way that the action of a drug depends on the quantity ingested rather than its distribution within the body. It may therefore be considered that the limitations of this dose measurement cannot be attributed to the measuring equipment used. They are the result of: (a) the fact that measurements cannot be made actually on the subject, who creates a secondary source of radiation. However, it may be hoped that better knowledge of radiation/human body interactions will eventually enable perfected personal dosimeters to be used which give an accurate indication of the dose received. In this field, sodium 24, although the activity measured is not directly proportional to the damage, is already an essential element. (b) the varied nature of radiation, which must be considered to be generally the case. It is unlikely that it will be possible to obtain more than a mean value in this case. Better knowledge of radiation fields and the influence of the ground, walls and all moderating masses will then enable the exposure conditions to be described to some extent. (auth)

21364 PERSONNEL DOSIMETRY USING THERMOLUMINESCENT DOSIMETERS. Cusimano, John P.; Cipperley, Foster V. (Atomic Energy Commission, Idaho Falls, Idaho). Health Phys., 14: 339-44(Apr. 1968). (TID-23798).

A routine system of personnel dosimetry utilizing thermoluminescence has been developed at the National Reactor Testing Station (NRTS). Research in thermoluminescent application techniques was initiated in early 1965 with the hope of developing a suitable system for long-term monitoring of personnel exposed to near background levels of radiation. The dosimeter utilizes two lithium fluoride-teflon disc dosimeters held in a plastic dosimeter retainer of the same size and shape as a standard film packet. The dosimeters are positioned in the open window area and the cadmium filter area of the NRTS badge. An insert in the plastic retainer concontains a punched binary code for identification. The experimental results are discussed in terms of reliability, reproducibility, response characteristics, and other factors that affect the validity of performance. The initial field experience of the system since its application in November 1966 is described. (auth)

21365 PLASTIC FOR RADIATION DOSIMETRY. Matsumoto, Shoichi (to Tokyo Shibaura Electric Co., Ltd.). Japanese Patent 1967-13539, Aug. 1, 1967. Filed Apr. 2, 1964.

The radiation-dosimetry plastic proposed is particularly suitable for gamma rays and electrons. Furthermore, its preparation and handling are simple and easy. The color and its condition upon irradiation can easily be observed with the naked eye, for comparison with those of the standard. Either vinyl chloride polymer, or vinyl chloride-vinyl acetate copolymer, or vinylidene chloride polymer--these are polymers containing chlorine--is mixed with an additive, which contains 3,3',5,5'-tetrabromo-m-cresolsulfonphthalein and p-dimethylaminoazobenzene in amounts (for each) not exceeding 1 wt%. The mixture is then molded into suitable forms. (NSA of Japan)

Radiometric Instruments

21366 EXPERIMENTAL AND THEORETICAL STUDIES ON THE GAMMA-RAY SCATTERING TECHNIQUE FOR MEASURING ATMOSPHERIC DENSITY. Gardner, Robin P. (North Carolina State Univ., Raleigh); Whitaker, Donald R. Nucl. Eng. Design, 7: 13-28(1968).

The gamma-ray scattering technique shows promise for use in the continuous measurement of atmospheric density from space vehicles. Mathematical models have been previously derived to predict the performance, identify problem areas, and explain the data taken on two flight tests of prototype devices. Design param-

eters such as gamma-ray source energy, source-to-detector separation, detector discriminator settings, and shield effectiveness were studied in an attempt to understand and optimize this technique. Experimental studies described were made to verify and improve (determine constants for) these mathematical models. The experimental results agreed quite well with the model predictions and indicate the effectiveness of this method for optimizing the design of the gamma-ray atmospheric density sensor. (auth)

21367 SELF-CONTROLLED SEQUENCE FOR AUTOMATIC STANDARDIZATION AND CALIBRATION OF NUCLEAR GAUGES. Lloyd, Walter B. (to Ohmart Corp.). U. S. Patent 3,348,046. Oct. 17, 1967. Filed Oct. 1, 1963.

A fully automatic system for standardizing beta-absorption thickness or density gages is described. The operation consists of moving the detector and beta source beyond the edge of the material to be measured, standardizing with the detector short-circuited to ground, standardizing on air, calibrating the apparatus for the material to be measured, and returning the beta source and detector to its measuring position. (W.H.K.)

21368 RADIOGRAPHIC SCREEN HAVING CHANNELS FILLED WITH A MATERIAL WHICH EMITS PHOTONS WHEN ENERGIZED BY GAMMA OR X-RAYS. Balding, George H. (to Kaiser Aerospace and Electronics Corp.). U. S. Patent 3,344,276. Sept. 26, 1967. Filed Mar. 30, 1964.

Design of an improved fluorescent screen for x-ray and gamma-ray radiographic uses is presented. The screen is designed to effectively collimate the outgoing light to improve the image resolution and contrast. (W.H.K.)

Miscellaneous Instruments and Components

Refer also to abstracts 21227, 21314, and 22858.

21369 (AEEW-R-583) DRIFT CORRECTION OF BINARY CROSS-CORRELATION MEASUREMENTS. Cummins, J. D. (Atomic Energy Establishment, Winfrith (England)). Oct. 1967. 15p. Dep. CFSTI. UK 2s. 6d.

Techniques are described for the elimination of quadratic and higher order approximations to drift of dependent variables in dynamic measurements on power plants, such as nuclear reactors. The techniques were developed for the Winfrith on-line binary cross-correlation, which uses pseudo-random chain codes. The techniques require that a length of recording of the output variables of the plant equivalent to two periods of the chain code be available to perform the off-line calculation, and only one selected term in the polynomial approximation to the drift is eliminated. For example, a correction for any linear drift may be made leaving a residual due to quadratic and higher powers. Drift correction of binary cross-correlation measurements is shown to be feasible at the expense of a longer recording time. The errors introduced to cross-correlation measurements for linear, quadratic, cubic, quartic, and quintic drift laws are presented in graphical form. (UK)

21370 (ANL-7418) APPLIED MATHEMATICS DIVISION SUMMARY REPORT, JULY 1, 1966-JUNE 30, 1967. (Argonne National Lab., Ill.). Contract W-31-109-eng-38. 90p. Dep. CFSTI.

A summary is presented of computer programs that were completed during the period. Also presented are summaries of activities in programming research and development, numerical and mathematical analysis, computer utilization in divisional research, computer engineering and computer systems, Argonne code center, and digital computer operations. Listings are included of publications, papers, seminars, and symposia. (W.H.K.)

21371 (APDA-304) PERMANENT MAGNET-TYPE FLOWMETERS AND THEIR APPLICATION IN THE ENRICO FERMI ATOMIC POWER PLANT. Ziniuk, Michael A.; Scott, Clyde C.; Meshii, Toshio (Atomic Power Development Associates, Ind., Detroit, Mich.). Mar. 1968. Contract AT(11-1)-865. 90p. Dep. CFSTI.

Stabilized precision magnetic flowmeters used in liquid-metal systems of reactors are defined with respect to design requirements, materials, fabrication practices, and calibration procedures. Analytical review of magnetic flowmeter theory is included to a limited extent. Discussion of the material aspects of magnets for flowmeters is limited to three widely used grades of Alnico since it has the desired properties. In 1956, when a decision was made to install permanent magnet-type flowmeters in the primary sodium system of the Enrico Fermi plant reactor, there was available only a limited amount of experience relative to flowmeters in liquid-metal systems. However, extensive design and experimental work had been performed with the permanent magnet-type flowmeters and several reports had been made on their application for measuring liquid-metal flow. Based on available information, the Atomic Power Development Associates, Inc., prepared specifications (subsequently given to the selected vendor) for the procurement of permanent magnet-type flowmeters. Several years after the primary system flowmeters were installed in the Fermi plant, calibration tests were attempted, with the use of data from the primary sodium pumps. The resulting experimental calibration curves revealed nonlinear relationships whereas the vendor's calibration curves were linear with respect to flow. The nonlinearities in the Fermi flowmeters were the result of the 0.7 ratio (approximate) of pole face length to pipe diameter for the 14-inch flowmeters. Conversely, the permanent magnet-type flowmeters of the secondary system had linear outputs with a 3.0 (approximate) ratio of pole face length to pipe diameter. (auth)

21372 (CEA-R-3363) SIMULATEUR ANALOGIQUE ELECTRONIQUE DE RADIOCARDIOGRAMMES. (Electronic Analog Simulator of Radiocardiograms). Roux, Georges; Lansiart, Alain; de Vernejoul, Pierre; Kellershohn, Claude (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires). Dec. 1967. 41p. (In French). Dep.

The various parameters of the heart pump and of the blood circulation can be determined by radio-cardiographical techniques. The curves thus obtained can be more easily used in radiocardiography if the electronic analog simulator described here is employed. The experimental and simulated radiocardiograms are made to coincide by varying the electrical parameters of the simulator. Using simple charts it is possible to obtain directly the actual original physiological parameters from these electrical parameters. Some examples are given showing the excellent accuracy obtained in the determination of ejection indices by the simulator. (auth)

21373 (CERN-67-33) DEVELOPMENT OF A LASER-TRIGGERED SPARK GAP. Deutsch, F. (European Organization for Nuclear Research, Geneva (Switzerland)). Dec. 28, 1967. 51p. Dep.

A delay line was discharged by a spark gap of coaxial design into a terminating resistor. The spark gap was triggered by an axially-introduced, focused laser beam. A Q-switched ruby laser giving a pulse of 20 nsec duration and up to 50 MW power was used. The range of operation of the gap and formative time of the breakdown and jitter were investigated for different gases at pressures higher than atmospheric, gap width of 4 to 10 mm and voltages of up to 120 kV. Mixtures of argon and nitrogen were found to have advantages for the foreseen application, such as low threshold for ionization by the laser beam, sufficient dielectric strength, low values of the formative time jitter, and chemical inertness. Formative times of down to about 1 nsec and jitters below 1 nsec were found. The laser power can be relatively low (0.5 to 5 MW). An explanation for the breakdown mechanism is proposed. (auth)

21374 (INR-869/XIV/PS) WYSOKOTEMPERATUROWA KAMERA RENTGENOWSKA DO BADAN STRUKTURALNYCH METALI I STOPOW W PROZNI. (High-Temperature Vacuum X-Ray Camera for Structural Investigations of Metals and Alloys). Baran, Zbigniew; Banach, Stanislaw; Czarnecki, Roman (Institute of Nuclear Research, Warsaw (Poland)). 1967. 25p. (In Polish). Dep.

The high temperature, vacuum x-ray camera permitting to have back Debye or Laue diffractograms from flat metallographic samples on a flat film is described. In the case of coarse polycrystalline samples the movement of the sample ascertains homogenous intensity of Debye rings. The range of temperatures is from room temperature to 800°C. The stability and accuracy of the temperature measurement is ±5°C. The sample is placed in special holder and heated by radiation from an electric lamp (1000 Watts), that is focused by a mirror on the sample. This method permits continuous regulation of the sample temperature by means of changing the power of the lamp. The great rate of sample heating 120°C/min., without introduction the heater into camera is also obtained. High vacuum about 10^{-6} mm. of Hg. in the camera gives the possibility of investigations the easy oxidable specimens. The accuracy of the lattice constants measurements is about 0.005 Å. (auth)

21375 (ORNL-4219) INSTRUMENTATION AND CONTROLS DIVISION ANNUAL PROGRESS REPORT FOR PERIOD ENDING SEPTEMBER 1, 1967. Sadowski, G. S. (comp. and ed.) (Oak Ridge National Lab., Tenn.). Feb. 1968. Contract W-7405-eng-26. 134p. Dep. CFSTI.

Separate abstracts were prepared for 15 of the 16 sections. The extra section was on biomedical research and not sufficiently within the scope of NSA. (W.H.K.)

For abstracts of individual sections see: 21314, 21315, 21376–21383, 22488, 22489, 22823, 22824, and 22858.

21376 (ORNL–4219, pp 1-3) NANOSECOND CIRCUITRY AND TECHNIQUES. (Oak Ridge National Lab., Tenn.).

A circuit diagram of a fast discriminator with trigger level proportional to the average signal level, to be used with delay lines in time-of-flight experiments, is presented. Also, a gamma detector using an array of thallium-activated sodium iodide scintillators for improved performance in a neutron time-of-flight experiment is described. (W.H.K.)

21377 (ORNL–4219, pp 4-17) PULSE COUNTING AND ANALYSIS. (Oak Ridge National Lab., Tenn.).

Circuit designs for various types of instrumentation for pulse counting and analysis are presented. Development of preamplifiers, amplifiers, discriminators, gates and coincidence circuits, pulse analyzers, and pulse generators are outlined. (W.H.K.)

21378 (ORNL–4219, pp 18-28) MISCELLANEOUS ELECTRONICS DEVELOPMENT. (Oak Ridge National Lab., Tenn.).

Circuits for a transistorized dc logarithmic electrometer, a high-field magnet pulser, a three dimensional scattered- light polariscope data sensing and recording system, a 400-kHz keyed oscillator–amplifier, and a mass selector for the quadrupole spectrometer are presented. A die-cast bin assembly is illustrated, and other developments are outlined. (W.H.K.)

21379 (ORNL–4219, pp 47-60) AUTOMATIC CONTROL AND DATA ACQUISITION. (Oak Ridge National Lab., Tenn.).

The development of computers for automatic control and data acquisition for nuclear instrumentation at ORNL is outlined. The circuit design for the prototype low-level gamma spectrometer and data acquisition system for the Lunar Receiving Laboratory is presented. (W.H.K.)

21380 (ORNL–4219, pp 61-7) DATA COLLECTION AND ANALYSIS. (Oak Ridge National Lab., Tenn.).

Developments outlined include analysis of pulse-height analyzer test data with a small computer, remote pulse-height analyzer and telemetry link, astronomical gamma-ray spectrometer, ribbon filament lamp and pyrometer calibration tables, data logging systems, scanivalve interface for the Dextir data logging system, new thermocouple tables, continuing programming support of the MSRE computer, and use of the Dextir data acquisition system for monitoring large numbers of strain-gage inputs in concrete pressure vessel tests. (W.H.K.)

21381 (ORNL–4219, pp 68-74) PROCESS INSTRUMENTATION AND CONTROL SYSTEMS ENGINEERING. (Oak Ridge National Lab., Tenn.).

Briefly discussed topics include the thorium fuel program, transuranium processing plant, fluidized bed volatility pilot plant, molten-salt vacuum distillation experiment instrumentation, waste-tank level alarm, in-cell creep-test instrumentation, process instrumentation for operating reactors, inproved control valve for radiochemical processing, valve position indicator, and a variable speed repeat cycle timer. (W.H.K.)

21382 (ORNL–4219, pp 75-86) PROCESS INSTRUMENTATION DEVELOPMENT. (Oak Ridge National Lab., Tenn.).

Topics discussed include the temperature standards program, water sampling instruments for ecology, microphone vibration transducers, hot-stage microscope differential thermal analyzer and furnace, extinction meter for backmixing measurements, cyclotron plate scanner, thermoelectric heat-pump calorimeter, program generators, high-stability voltage source for portable instruments, automatic temperature controller for low-temperature adiabatic calorimeter, flow computer for HFIR hydraulic tube, test and evaluation of a quartz thermometer, pneumatic signal scanner (Scanivalve) transducer tests, and test and evaluation of a photoelectric automatic pyrometer. (W.H.K.)

21383 (ORNL–4219, pp 116-18) INSTRUMENT DEPARTMENT MAINTENANCE AND SERVICE. (Oak Ridge National Lab., Tenn.).

Topics discussed include maintenance activities of the monitoring systems development group, activities of the special electronic services group, maintenance services for the solid state division, sound attenuation tests on walls, and electronic services for the neutron physics division. (W.H.K.)

21384 (ORNL-TM–2123) FABRICATION OF AN IMPROVED FROST-POINT HYGROMETER SENSING ELEMENT. Prislinger, J. J.; Jury, S. H. (Oak Ridge National Lab., Tenn.). Apr. 1968. Contract W-7405-eng-26. 11p. Dep. CFSTI.

A new frost-point hygrometer sensing element is described wherein design for superior performance generates metal joining problems involving gold, silver, Monel, stainless steel, and Invar. The solutions to these problems and the method of fabrication are described in detail. (auth)

21385 (PINSTECH/PHY–11) DESIGN OF A TRANSISTORISED UNIT FOR AUTOMATIC CHANNEL STEPPING OF 512-CHANNEL LABEN ANALYSER. Ali, Ahmed (Pakistan Inst. of Nuclear Science and Technology, Islamabad. Nuclear Physics Div.). Aug. 1967. 7p. Dep.

The design of a transistorized unit for automatic channel stepping of the 512-channel Laben Analyzer operating in the multiscaler mode is described. The unit is very useful for determining short half-lives. It can accept count rates up to 100 kc/sec. (auth)

21386 (RT/EL–(67)12) UN AMPLIFICATORE LOGARITMICO E DI PERIODO PER IL CONTROLLO AUTOMATICO DI IMPIANTI NUCLEARI. (Logarithmic and Period Amplifier for Automatic Control of Nuclear Installations). Malosti, D.; Manzo, D.; Rinonapoli, C. Volpe (Comitato Nazionale per l'Energia Nucleare, Rome (Italy)). 1967. 44p. (In Italian). Dep.

A period and logarithmic amplifier is described. The logarithmic element is a planar silicon transistor whose logarithmic characteristics, errors, and drift are analyzed. The experimental characteristic curve is given with a precision within some units per 1000 of one decade for 10^{-11} A to 10^{-4} A input currents and within 2% of one decade for 10^{-4} A to 10^{-3} A. Stability, time of response, and output noise of the whole system are analyzed. The response time is varying in connection with the input signal amplitude in order to be optimized with reference to the noise. (auth)

21387 (SC-M–68-94) AEC/NASA SYMPOSIUM ON CONTAMINATION CONTROL HELD AT ALBUQUERQUE, NEW MEXICO, SEPTEMBER 12–14, 1967. Subject: CURRENT AND ADVANCED CONCEPTS IN INSTRUMENTATION AND AUTOMATION. Sanguinetti, Mario J. (ed.) (Sandia Corp., Albuquerque, N. Mex.). 344p. (CONF-670919). Dep. CFSTI.

Instrumentation for measuring contamination for aerospace applications is described. Contamination in liquids, on surfaces, in air and gases, and microbial contamination are discussed. Methods and instrumentation for monitoring radioactive contamination are outlined. Also, a systems approach to contamination control is presented. (W.H.K.)

21388 (TRG-Report-1640) AN EXPERIMENTAL CONTINUOUS-INDICATION PLUGGING METER FOR IMPURITY MONITORING IN LIQUID ALKALI METALS. Davidson, D. F.; Roach, P. F. (United Kingdom Atomic Energy Authority, Risley (England). Reactor Group). 1968. 15p. Dep. CFSTI. UK 2s. 6d.

Plugging meters are useful for detecting changes in the gross impurity level of liquid alkali metals. For the coolant circuits of a fast reactor, automatic as opposed to manual measurement of the plugging temperature is required. The development of an experimental automatic instrument, designed to have a fast response and display a continuous record of plugging temperatures, is described. The liquid metal supply to the instrument flows from zero differential pressure sampling points on the external system and circulation is maintained by using a separate pump. With this design, the flow emerging from the cooler has two alternative routes, one through the orifice and one by-passing it. The by-pass flow is guided near the orifice and aids rapid unplugging. Under automatic control, the orifice is partially blocked with impurities. The temperature of the liquid metal near the orifice is adjusted to keep orifice flow a fixed fraction of its unplugged flow (i.e., at the saturation value). This temperature is measured and indicated. The instrument has operated in sodium over a range of saturation temperatures from 250°C, where the temperature swings were ±1°C, down to 125°C (<7 ppM for a sodium/oxygen system) where the temperature swings were ±5°C. (auth)

21389 (UCID–15254) GLASS-METAL ENVELOPE FOR HIGH VACUUM X-RAY IRRADIATION OF SPECIMENS AT ELEVATED TEMPERATURES. Peterson, C. A. W.; Steele, W. J. (California Univ., Livermore. Lawrence Radiation Lab.). Jan. 31, 1968. Contract W-7405-eng-48. 20p. Dep. CFSTI.

Description of a high-vacuum tube for x-ray irradiation of specimens at elevated temperatures is presented. X-ray diffraction data, obtained using the tube, are presented for a Mulberry alloy at 150 to 573°C. (W.H.K.)

21390 (AEC-tr-6930) CONSTRUCTION OF A RING-ELECTRODE VOID METER. Satomi, Masahiro; Ogasawara, Eio; Kashiwai, Shinichi. Translated for Battelle-Northwest, Richland, Wash., from pp 515-18 of Proceedings of the Sixth SICE Technical Conference, [Japan], October 13-15, 1967. 9p. Dep. CFSTI. JCL $1.10 fs, $0.80 mf.

An electronic ring-electrode type void meter is described for measuring void fractions in the boiling water reactor. The meter was tested by measuring transient boiling voids and void fractions in high-speed, two-phase flow. (W.H.K.)

21391 LARGE ZINC NEUTRON MONOCHROMATOR WITH AN INCREASED MOSAIC SPREAD. Modrzejewski, A. (Inst. of Nuclear Research, Swierk, Poland). Krist. Tech., 2: 451-3 (1967).

A large zinc neutron monochromator with an increased mosaic spread which was prepared for diffraction work with cold neutrons from the IBR pulsed reactor in the Joint Institute for Nuclear Research at Dubna is described. This monochromator was used in studies of lattice dynamics in molecular crystals. (auth)

21392 PRODUCTION OF INTENSE HOMOGENEOUS MAGNETIC FIELDS IN A SUPERCONDUCTING CABLE FOR A NUCLEAR MAGNETIC RESONANCE SPECTROMETER. Miscopein, J. (Compagnie Francaise Thomson Houston, Chatou, France). pp 311-15 of Les Champs Magnetiques Intenses, leur Production et leurs Applications. Paris, Centre National de la Recherche Scientifique, 1967. (In French).

From International Colloquium on Intense Magnetic Fields, their Production and their Applications, Grenoble, France. See CONF-660921.

After a brief review of high magnetic fields for observation of nuclear resonance phenomena, the design of a 47-kG homogeneous magnetic field for a spectrometer operating at 200 MHz with a superconducting coil is discussed. The obtained homogeneity is some 10^{-4} in a 2-cm-diameter sphere, and with local magnetic shims, ~10^{-6} homogeneity is hoped for in a 10-mm^3 volume. The cryostat and power supply are also described. (auth)

21393 SIMPLE CONVERSION OF A SPECTROGRAPH TO A RECORDING SPECTROMETER, IN PARTICULAR FOR THE MEASUREMENT OF THE RELATIVE ABUNDANCES OF NITROGEN ISOTOPES. Leicknam, J. P.; Figdor, H. C.; Keroe, E. A.; Muehl, A. (Agence Internationale de l'Energie Atomique, Niederosterreich, Austria). Int. J. Appl. Radiat. Isotop., 19: 235-47(Mar. 1968). (In French).

A spectrograph originally designed for photographic recording was converted to an automatic recording spectrometer, making use of two commercially available motors and gear-boxes. A large choice of recording speeds is thereby attained, enabling a study of an extended spectral range in general or the exploration of a few Å in detail. The spectral quality produced by the instrument is adequate for accurate measurement of the relative intensities of emission lines or molecular bands; in particular, bands corresponding to N_2^{14}, $N^{14}N^{15}$ and N_2^{15} were sufficiently well resolved for the isotopic analysis of nitrogen by this instrument. The design of high frequency apparatus of high stability for the electrodeless discharge in gases is described. The spectra of various molecules were recorded, which involved consideration of the design of the discharge tubes and the mode of gas excitation. The preparation of a discharge tube for ^{15}N analysis takes about 10 min. (auth)

21394 GAS DETECTORS. Shand, A. J. (Univ. of California, Berkeley). Annu. ISA (Instrum. Soc. Amer.) Conf. Proc., 22: 11.1.AID/CHEMPID.67.1-7(1967).

From 22nd Instrument-Automation Conference and Exhibit, Chicago. See CONF-670903-(Pt.4).

Gas detectors have proven to be invaluable in the field of safety. The more important uses and also abuses are briefly described. Because of the varied types in use, the advantages and disadvantages are numerous and are important enough to warrant serious discussion. In the scope of flammable gas detectors few details are unimportant, but in this discussion an attempt will be made to describe several experiences with regard to specific location and the determination of detector placement. Technically a discussion of various types of detectors is important in describing their specifications and operating parameters. Finally, a clearer understanding of operating principles and applications will lead to better safety systems. (auth)

21395 RECENT INSTRUMENTATION IN NUCLEAR MEDICINE. Kurihara, Shigeyasu; Sano, Terusato (Tokyo Shibaura Elec. Co., Ltd.). Toshiba Rebyu, 23: 146-51(Feb. 1968). (In Japanese).

Clinical application of radioisotopes in Japan, though hitherto most widely practiced in therapy, has recently made marked progress in diagnosis. The progress in these fields has established a new scope, nuclear medicine. Such a state is primarily due to the advance in radiopharmaceuticals and instrumentation. A few types of instrumentation systems for this field developed by Toshiba are described. (auth) (NSA of Japan)

21396 DEVICES FOR ANALYZING PHYSICAL PHENOMENONS, AND IN PARTICULAR NUCLEAR PHENOMENONS. Avril, Michel; Moreau, Raymond; Pages, Alix (to Commissariat a l'Energie Atomique). U. S. Patent 3,345,616. Oct. 3, 1967. Priority date Jan 15, 1963, France.

The design of a versatile multichannel pulse analyzer system to be used with pulse-type radiation detectors is presented. Circuit diagrams are included. (W.H.K.)

21397 APPARATUS FOR ANALYZING A GASEOUS MEDIUM BY SUBJECTING THE GAS TO ELECTRON BOMBARDMENT AND MEASURING THE CHARACTERISTIC X-RAY EMISSION. Ziegler, Charles Albert (to Parametrics, Inc.). U. S. Patent 3,344,273. Sept. 26, 1967. Filed Sept. 24, 1964.

The system is designed for measuring atmospheric density and composition at high altitudes from space vehicles. The principal components are an electron gun and an x-ray detector and analyzer system. (W.H.K.)

21398 SHUMY I PARAMETRICHESKIE YAVLENIYA V ELEKTRONNYKH PRIBORAKH SVERKHVYSOKIKH CHASTOT. (Noises and Parametric Phenomena in High-Frequency Electron Devices). Lopukhin, V. M.; Magalinskii, V. B.; Martynov, V. P.; Roshal', A. S. Moscow, Izdatel'stvo Nauka Glavnaya Redaktsiya Fiziko-Matematicheskoi Literatury, 1966. 372p.

A systematic account is given of the noise factor theory in high-frequency electron fluxes and of the noise theory in parametric electron beam devices with longitudinal and transverse fields. The minimum noise coefficient was calculated for single- and multi-velocity regions. The influence of electrostatic field in electron guns on the noise coefficient, new mechanism of noise reduction in electron beam amplifiers, effects of space-charge and transit time on the shot noise in diodes, low-noise microwave quadrupole amplifiers, and calculations of equations of convection current in accelerating field are discussed. (R.V.J.)

21399 CALUTRON WITH MEANS TO DIRECT CALCIUM GETTERING VAPOR INTO THE ION BEAM TO REDUCE TANK PRESSURE. Bell, W. A. Jr.; Spainhour, K. A.; Veach, A. M. (to United States Atomic Energy Commission). U. S. Patent 3,376,414. Apr. 2, 1968.

This patent relates to a calutron wherein a calcium boiler is positioned within the tank unit of the calutron such that the calcium vapor from the boiler is directed toward the calutron ion beam and the vapor encompasses the greater portion of the ion beam. The gettering action of the calcium helps to further reduce the tank pressure. However, the ion outputs for most isotopes, when the calcium boiler is utilized, are increased by at least tenfold over what was expected on the basis of improved vacuum alone, and ion beam resolutions are also greatly improved. (AEC)

21400 RADIATION DETECTOR READOUT SYSTEM. Cashion, K. D.; Baker, B. R. (to United States Atomic Energy Commission). U. S. Patent 3,358,145. Dec. 12, 1967.

This patent relates to a circuit utilizing a highly stable variable current source which is combined with the dark current signal when no light signal is fed into a photomultiplier tube, and causes the resultant output signal of the circuit to be zero. When an input light signal is fed into the photomultiplier tube, with the current source connected to the circuit having a value equal to but opposite in polarity to the dark current of the photomultiplier tube, the resultant output signal is proportional to the input signal, and low intensity light signals may be readily measured by the circuit since the signal-to-noise ratio has been substantially reduced. (AEC)

21401 APPARATUS FOR CONTINUOUS OXYGEN MONITORING OF LIQUID METALS. Kolodney, M.; Steinmetz, H. (to United States Atomic Energy Commission). U. S. Patent 3,378,478. Apr. 16, 1968.

This patent relates to an oxygen monitor for liquid sodium in which a galvanic cell is employed. The galvanic cell relies on the emf developed between an inert electrode immersed in the sodium and a metal-metal oxide electrode separated from the sodium by a solid electrolyte of ZrO_2 containing an oxygen carrier. (AEC)

Radiation Effects on Instruments and Instrument Components

21402 (CEA-R-3313) CONTRIBUTION A L'ETUDE DU COMPORTEMENT DES TRANSISTORS SILICIUM A STRUCTURE

PLANE SOUMIS AUX RAYONS "GAMMA" DU ^{60}Co. (Contribution to the Study of the Behavior of Silicon Planar Transistors Exposed to the ^{60}Co γ Rays). Le Ber, Jacques (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires). Dec. 1967. 59p. (In French). Dep.

Thesis. Submitted to Faculte des Sciences, Paris Univ., Orsay, France.

An account is given of studies carried out on bipolar silicon planar transistors irradiated by ^{60}Co γ rays. The interactions on the matter of the different types of particles are described and a brief bibliographical recall of foreign studies is presented. The technological structure of the planar transistors is then described in order to help the understanding of the phenomena, general comments are made about the choice of measured parameters and on the statistical interpretation of results. An automatic instrument for the measurement of the gain is described and the reproductibility of the results is stated. The complexity of the problem and the difficulty to predict the behavior of the semiconductors' components are clearly shown. It is stated that the observed dispersions depend on: the electrical bias during irradiation, the injection level in the emitter-base junction during the measurement, the manufacturer for a given type, the instantaneous dose rate, and the geometry used. The problem is then examined from the reliability point of view and methods are given to evaluate the reliability for a given dose. These are the "Worst case" method, moment method, and Monte Carlo method. (auth)

LIFE SCIENCES

Biochemistry, Physiology, and Molecular Biology

Refer also to abstracts 21023, 21024, 21206, 21466, 21476, 21477, 21481, 21502, 21525, 21550, 21586, 21591, 21598–21606, 21608, and 21631.

21403 (ACRH–1000–39) EFFECT OF ENDOGENOUS ERYTHROPOIETIN ON REPLICATING HEMOPOIETIC STEM CELLS. DeGowin, Richard L.; Johnson, Shirley (Chicago Univ., Ill. Dept. of Medicine. Argonne Cancer Research Hospital, Chicago, Ill.). June 13, 1967. Contract AT(11-1)-69. 12p. Dep. CFSTI.

Autorepopulation studies using a radiobiological method provide evidence that endogenous hemopoietic stem cell proliferation in the shielded mouse occurs during the first five days after irradiation. Exposure to hypoxia, sufficient to produce elevated levels of endogenous erythropoietin, failed to induce erythroid differentiation during the early proliferative phase of marrow repopulation. The data support the concept that the replication of stem cells, per se, renders them refractory to the induction of erythroid differentiation by erythropoietin. (auth)

21404 (COO–301–150) STUDY OF FACTORS INFLUENCING HORMONE SECRETION RATES AND METABOLIC PATHWAYS USING RADIOACTIVE ISOTOPES AS TRACERS. Progress Report, 1954–1967. (Missouri Univ., [Rolla]). Jan. 1968. Contract AT(11-1)-301. 57p. DTIE.

Methods of measuring secretion rates of thyrotropic hormones, the thyroid hormones, thyroxine and triiodothyronine, adrenal cortical hormones, and ovarian hormones were developed. Normal variations in thyroid hormone secretion rates were studied in cattle, fowl, rats, raccoons, opossums, shrews, moles, mice, and hamsters. The isotopes ^{131}I, ^{31}P, and ^{32}P were used in these studies. Experiments designed to determine causes of variation in thyroid hormone secretion rates were initiated to determine the feasibility of using these determinations in selecting animals for production characteristics such as milk or egg production. The results show that environmental temperature and seasonal changes play an important role in the regulation of thyroid hormone secretion rate. The interaction of the thyroid hormones with those of the adrenal glands and gonads was investigated. The results showed that the absence of adrenals or gonads depressed thyroid hormone secretion significantly, while the replacement or addition of steroids from the adrenals or gonads resulted in a return of thyroid hormone secretion rates to normal or above-normal levels. Studies on adrenalectomy, thyroidectomy, and hypophysectomy showed that food consumption was markedly reduced. Underfeeding experiments showed that thyroid secretion rates were markedly reduced during periods of reduced food intake. Experiments with heifers showed that estrogens stimulated lactation. The administration of exogenous thyroxine to lactating cows resulted in an increased rate of elimination of radioactive iodine into the milk and urine. The oral effectiveness of thyroid hormones was studied to determine doses to be administered for improvement of productive performance. Studies on progesterone and its metabolites in mammals showed that the majority of metabolites of progesterone in cattle appeared in the feces as C-19 steroids. Half-lives of progesterone were determined, and blood levels were measured in order to calculate secretion rates of the steroids. (auth) (TSS)

21405 (CU–1803–12) ACTIVATION OF HYDROGEN DEUTERIUM IN BIOLOGICAL SYSTEMS. Technical Progress Report. Rittenberg, David (Columbia Univ., New York. Coll. of Physicians and Surgeons). Oct. 25, 1967. Contract AT(30-1)-1803. 6p. Dep. CFSTI.

The rate of oxidation of various deuteriosuccinic acids was studied. It was found that the reduced flavin that is an intermediate in the oxidation of deuteriosuccinate exchanges the deuterium atom with the hydrogen of the water at a rather slow rate. The stereochemistry of deuteriosuccinate formed in D_2O by an exchange catalyzed by succinic dehydrogenase was studied. The system resulted in formation of a monodeuteriosuccinate. Research was continued on the abundance of deuterium in organic compounds of biological origin. Analysis of organic compounds from a core of the Mohole Project was completed. The deuterium analysis of the fatty acids relative to the water isolated from the core is close to the values found for fatty acids isolated from rats and fish. The rate of the non-enzymatic exchange with ^{18}O labeled H_2O of dihydroxyacetone, dihydroxyacetone-phosphate and the effect of aldolase on the exchange reaction of ^{18}O labeled fructose, fructose-1-phosphate and fructose-1,6-diphosphate were studied. The data show that phosphorylation increases the rate of the exchange reaction of the non-enzymatic reaction and that aldolase also increases the rate of exchange of the fructose phosphates. The mechanism of activation of the hydrogenase of Proteus vulgaris with visible or ultraviolet light is being studied. (H.L.W.)

21406 (KFKI–6/1967) DETERMINATION OF SODIUM AND POTASSIUM BY NEUTRON ACTIVATION ANALYSIS FOR THE INVESTIGATION OF THE ELECTROLYTE-BALANCE OF THE INNER EAR. Oerdoegh, M.; Miriszlai, E. (Magyar Tudomanyos Akademia Kozponti Fizikai Kutato Intezete, Budapest). Apr. 10, 1967. 17p. Dep.

Neutron activation analysis was used to determine Na and K in small amounts of human serum. The samples were irradiated with 2.10^{13} n/cm^2 sec neutron flux of the VVR-S type reactor. Methods for precipitating K are described. Samples of perilymph were collected and analyses of Na and K were made by flame photometry and isotope exchange techniques. Results are tabulated. The importance of determining electrolytes of the inner ear fluids in diagnosis is pointed out. (H.L.W.)

21407 (PRNC–104) MARINE BIOLOGY PROGRAM PROGRESS SUMMARY REPORT NO. 5, JUNE 1966 TO JUNE 1967. Lowman, F. G.; Phelps, D. K.; Ting, R. Y.; Martin, J. H.; Swift, D. J.; Escalera, R. McClin (Puerto Rico Nuclear Center, Mayaguez). July 1967. Contract AT(140-1)-1833. 419p. Dep. CFSTI.

Separate abstracts were prepared for 14 papers of this report. Various aspects of biological research, geological research, and chemical methods are presented. Appendices giving stable element analyses and computer programs are included. (H.L.W.)

For abstracts of individual sections see: 21023–21028, 21216–21218, 21408, 21409, and 22902–22904.

21408 (PRNC–104, pp 54–6) A COMPARISON OF STABLE ELEMENTS IN THE NINE-ARMED STARFISH COLLECTED FROM TWO SITES OFF THE WEST COAST OF PUERTO RICO. (Puerto Rico Nuclear Center, Mayaguez).

Specimens of the starfish, Luidia senegalensis, were collected from two geochemical areas off the west coast of Puerto Rico. They were analyzed for Cd, Co, Cu, Mg, Fe, Mn, Ni, Pb, Sr, and Zn. The patterns of distribution for these elements were the same from both areas except for Fe and Zn and the feeding habits of the starfish were noted. Uptake studies using ^{59}Fe and ^{65}Zn are being conducted on these organisms. (H.L.W.)

21409 (PRNC–104, pp 83–9) ^{110}Ag UPTAKE BY THE SPINY LOBSTER, PANULIRUS ARGUS. (Puerto Rico Nuclear Center, Mayaguez).

Three spiny lobsters, Panulirus argus, were put into a tank containing filtered sea water to which was added ^{110}Ag and antibiotics. After a period of 523 hours the level of radioactivity in the sea water remained steady indicating that the lobsters had reached an uptake equilibrium. The lobsters were removed and the ^{110}Ag content of the various organs was determined. The hepatopancreas contained the largest amount. The brain, gonads, and muscles had a lesser retention time than did other organs. (H.L.W.)

21410 (YALE–2653–30) RESEARCH ON THE EFFECTS OF RADIATIONS ON BIOLOGICAL MOLECULES, ON AGGREGATES OF SUCH MOLECULES IN VITRO, AND ON MOLECULES AND AGGREGATES WITHIN CELLS. Summary Report, November 1, 1960–July 1, 1967. Hutchinson, Franklin (Yale Univ., New Haven, Conn.). Contract AT(30-1)-2653. 9p. Dep. CFSTI.

Progress is reported on the following studies: loss of reproductive ability of bacteria and viruses following radiation damage to DNA, effects of ionizing radiation on transforming activity of DNA; inactivation of single stranded and double stranded DNA molecules; effects of uv light on bromouracil-labeled DNA; correlations between electron spin resonance signals detected in dry irradiated samples of DNA and loss of biological activity; development of a method for extracting very large pieces of DNA from a bacterial cell; biological effects of ionizing radiations on mammalian cells; nature of RBE versus LET response for survival and chromosome damage; effects of BUdR on radioinduced mitotic delay; effects of triacetoneamine nitroxide on sensitivity of anoxic cells to radiation damage; radiosensitivity of cells of mice during mitosis. (H.L.W.)

21411 ROLE OF MACROPHAGES IN THE INDUCTION OF ANTIBODY IN X-IRRADIATED ANIMALS. Gallily, Ruth;

Feldman, M. (Weizmann Inst. of Science, Rehovoth, Israel). Immunology, 12: 197-206(Feb. 1967).

The function of macrophages in inducing antibody production to Shigella antigen and the effect of x irradiation on the immunogenic function of macrophages were studied. Peritoneal macrophages, that were incubated with Shigella and then injected into mice exposed to 550 R, triggered the formation of agglutinating antibody in animals that did not respond to the injection of the antigen alone. The antibody formed was not produced by contaminating lymphocytes of the peritoneal exudate, since lymph node cells at doses higher than those of the macrophage inocula did not produce antibody when treated and injected under similar conditions, and lymphocyte-free macrophage populations, obtained by culturing in vitro cells of peritoneal exudates, triggered the production of antibody when injected into x-irradiated recipients after interaction with the antigen. Macrophages from x-irradiated donors incubated with Shigella were incapable of inducing antibody formation in x-irradiated mice. Animals exposed to higher doses of irradiation (900 R) did not produce antibody following injection of macrophage-antigen complexes. It was concluded that macrophages from normal animals elicited the production of antibody by the lymphoid cells of the irradiated recipients. (BBB)

21412 CORRELATION OF γ RAY INACTIVATION AND STRAND SCISSION IN THE REPLICATIVE FORM OF ϕX174 BACTERIOPHAGE DNA. Taylor, William D.; Ginoza, William (Pennsylvania State Univ., University Park). Proc. Nat. Acad. Sci. U. S., 58: 1753-7(Oct. 1967).

The γ-inactivation of ϕX174 RF-DNA is caused mainly by single-strand scissions, base or other damage, and to a very small extent by double-strand scissions. The efficiency of inactivation by single-strand breaks and base or other damage is 0.25. (auth)

21413 RADIOACTIVITY OF BRAZIL NUTS. Penna-Franca, E.; Fiszman, M.; Lobao, N.; Costa-Ribeiro, C.; Trindade, H.; Dos Santos, P. L.; Batista, D. (Univ., Rio de Janeiro. Instituto Nacional de Pesquisas do Amazonas, Manaus, Brazil). Health Phys., 14: 95-9(Feb. 1968).

It has been known for some time that Brazil nuts have a high barium content and their natural radioactivity is the highest among foodstuff grown in areas of normal radiation background. Samples of Brazil nuts of known origin, as well as various parts of their trees, were obtained from different regions of the Amazon valley and analyzed for barium, calcium, ^{226}Ra, ^{228}Ra, and total alpha activity. No statistically significant correlation was found between concentrations of calcium and barium in the nuts. In general, however, the samples richer in barium had the highest concentration of radium. In samples of different parts of the same tree a certain parallelism was noticed between barium and radium contents. The high radioactivity of Brazil nuts was explained, in agreement with the opinion of other authors, by its tree capacity of absorbing and concentrating barium, which is the natural carrier of radium. Some observations were made on the possibilities of people who consume a considerable amount of the nuts, during many years, building up elevated radium body burdens. (auth)

21414 INFLUENCE OF MICRO-ORGANISMS ON THE DISTRIBUTION IN ROOTS OF PHOSPHATE LABELED WITH ^{32}P. Barber, D. A.; Sanderson, J.; Scott, Russell R. (Agricultural Research Council Radiobiological Lab., Wantage, Eng.). Nature (London), 217: 644(Feb. 17, 1968).

An autoradiographic study is described of the way in which micro-organisms influence the distribution of phosphate between different root tissues. Results are shown for transverse sections of roots of 3-week barley plants that were supplied with potassium phosphate containing ^{32}P. In roots that were grown under sterile conditions phosphate was distributed relatively uniformly throughout the cortex, but there was a marked accumulation in the stele. The presence of micro-organisms, however, led to considerable concentration of phosphate in irregular zones close to the root surface; these are attributed to accumulation of the ion in colonies of bacteria. It is pointed out, however, that unless plants are grown under rigidly sterile conditions the observed distribution of phosphate between the root cortex and other tissues cannot be regarded as resulting solely from plant metabolism. (UK)

21415 EFFECT OF ULTRAVIOLET IRRADIATION ON ACID-SOLUBLE COLLAGEN. Davidson, R. J.; Cooper, D. R. (Rhodes Univ., Grahamstown, South Africa). Biochem. J., 105: 965-9 (Dec. 1967).

A study was made of the effect of ultraviolet irradiation on the conformational changes taking place in cooled solutions of thermally denatured acid-soluble calf-skin collagen. The increase in negative rotation and viscosity at 15° for irradiated and thermally denatured collagen solutions became less as the irradiation dose was increased. The principal effect of ultraviolet irradiation is fission of the primary collagen chains, eventually yielding chain lengths incapable of stabilizing a helical structure. The effects of ultraviolet irradiation on acid-soluble collagen may be closely correlated with similar effects on neutral salt-soluble collagen. (auth)

21416 REACTION OF Pu(IV) WITH THE IRON TRANSPORT SYSTEM IN HUMAN BLOOD SERUM. Stover, Betsy J.; Bruenger, F. W.; Stevens, W. (Univ. of Utah, Salt Lake City). Radiat. Res., 33: 381-94(1968).

When human blood serum that was tagged in vitro with monomeric Pu(IV) was subjected to gel filtration, most of the Pu(IV) was found in two molecular-weight ranges, that of the low-molecular-weight serum proteins and that of small molecules and ions. The distribution of Pu(IV) between the two peaks was variable. In addition, a small amount was eluted in the highest-molecular-weight fraction. By a combination of gel filtration, ion exchange, and electrophoresis the Pu(IV) protein complex was isolated, and the protein was identified as transferrin, the protein that transports iron. Pu(IV) appeared to be bound at the iron-binding sites, and the reaction between Pu(IV) and transferrin was shown to be reversible. The stability constant of the complex is high but less than that of the very stable Fe(III) transferrin complex. The variation in distribution of Pu(IV) between transferrin and the low-molecular-weight region thus is related to the variation in the amount of iron bound by the transferrin. (auth)

21417 EFFECTS OF β-INTERNAL (^{32}P) IRRADIATION ON THE 5-HT CONTENT OF CNS LEVELS. Egana, E.; Velarde, M. I. (Univ. of Chile, Santiago). Experientia, 23: 526-7(July 15, 1967).

The content of 5-hydroxytryptamine in the central nervous system of rats was increased by small doses of β radiation. In experiments with larger doses the 5-HT content decreased. A table is presented to show the 5-HT content of normal and irradiated brain cortex, diencephalon, hypothalamus, olfactory bulbs, mesencephalon, and spinal cord. (H.L.W.)

21418 EFFECTS OF BLOCKING AGENTS ON THE UPTAKE OF COLLOIDAL CHROMIC RADIOPHOSPHATE BY BONE AND BONE MARROW. Anghileri, Leopoldo J. (Krebsforschungszentrum, Heidelberg). Nucl.-Med., 6: 455-61(Dec. 30, 1967).

After injection of a blocking agent, the uptake of subsequently administered colloidal chromic radiophosphate by liver, lung, spleen, and skeleton of rats was measured. When the blocking colloid was injected intraperitoneally the time elapsed between both injections was not as critical as after intravenous injection, but its effect on skeleton uptake was more pronounced. Of the colloids assayed, the iron-fructose complex showed the highest efficiency in reducing the uptake by liver and skeleton. (auth)

21419 INDUCTION AND MECHANISM OF IMMUNOLOGICAL TOLERANCE TO TRANSPLANTATION ANTIGENS IN PARABIOSIS OF ADULT MICE. Skowron-Cendrzak, Anna (Polish Academy of Sciences, Krakow). Folia Biol. (Warsaw), 15: 405-83 (1967). (In Polish).

Skin grafts were made in mice in parabiosis and factors influencing the cross-circulation were studied. Amethopterin did not change the time required for tolerance induction to the Y-chromosome antigen in pre-immunized mice. Tolerance to the Y-antigen induced in parabiosis was abolished by sublethal x radiation. (H.L.W.)

21420 THE COMPARATIVE UV-SENSITIVITY OF PHAGES 1_{ϕ}-7 AND T7 AND OF THEIR INFECTIOUS NUCLEIC ACIDS. Dityatkin, S. Ya; Danilcichenko, V. V.; Zavil'gel'skii, G. B.; Il'yashenko, B. N. (Inst. of Molecular Biology, Moscow). Genetika, No. 11, 87-93(Oct. 1967). (In Russian).

It was shown by the comparative analysis of the inactivation curves of the uv-irradiated phage 1_{ϕ}-7 and of its infectious DNA at different wavelengths, that at λ = 254 mμ the main target of the phage is its DNA. With the increase of the wavelength of uv (254, 265, 280, 302 mμ) the proportion of lethal damages associated with the protein component of the phage increases. At the 302 mμ wavelength the sensitivity of the phage is 1.5 times as high as that of the infectious DNA. Phage T7 is more sensitive to uv than its infectious DNA. In the region of low uv doses the slant of the inactivation curve of the phage is about 1.5 times as steep as that of the inactivation curve of its infectious DNA. A similar ratio persists at all the uv wavelengths used (see above). It can be assumed that the higher sensitivity of the phage T7, as compared to its DNA, is associated mainly with the differences in the efficiency of the repairing system of the spheroplasts infected by the phage DNA, and of that in the asynchronous population of the phage-infected bacteria. (auth)

21421 FACTORS AFFECTING THE STABILITY OF CHLORTETRACYCLINE, TYLOSIN, AND FURYLFURAMIDE AGAINST LOW LEVEL OF IONIZING RADIATION. Kawabata, Toshiharu (National Inst. of Health, Tokyo); Kozima, Tsuneo; Shimura, Naohiko; Yoshimura, Eizo. J. Food Sci., 33: 110-13(Jan.-Feb. 1968).

The effects of low levels of ionizing radiation (0.01 to 0.2 Mrad) on the stability of chlortetracycline (CTC), furylfuramide (FF) and tylosin (Tl) were investigated. Tylosin in the phosphate buffer of pH 6 to 8 was very sensitive to low-level radiation, while either FF or CTC exhibited fairly high resistance at the same dose levels. Removal of dissolved oxygen in the test solution by aerating with nitrogen gas enhanced the inactivation of Tl and FF at 0.05 to 0.1 Mrad of radiation, but it had an opposite effect on the inactivation of CTC. Much higher Tl and CTC activities were retained after irradiation at 0.1 or 0.2 Mrad when the drugs were added to albumin, gelatin, broth or minced meats of five species of fish; the retention of FF did not change. The remaining activity of Tl at 0.1 or 0.2 Mrad of radiation was more or less influenced by adding various sugars and amino acids. The presence of sugars (mono- or disaccharides) did not change retention of Tl markedly, but gave a weak protective effect. Tryptophan, histidine, phenylalanine, methionine and tyrosine exhibited a fairly high protective action on the inactivation of Tl after irradiation. (auth)

21422 INVESTIGATION ON THE EXCHANGE OF ^{45}Ca IN INTACT AND BURNED RATS BY KINETIC ANALYSIS METHOD. Movshev, B. E. (Inst. of Medical Stomatology, Moscow). Vop. Med. Khim., 14: 12-16(Jan.-Feb. 1968). (In Russian).

Kinetics of ^{45}Ca excretion from the blood and its incorporation into the femur after i. v. isotope administration were studied. Equations for both processes in intact animals consisted of four exponential terms. Three days after the burn kinetic equations reflect the increased ^{45}Ca excretions from the blood, an increase in isotope incorporation into the bone, and excretion process. Fifteen days after the burn the excretion of ^{45}Ca from the blood is decreased. The same takes place for the isotope incorporation into the bone. At the same time the excretion of ^{45}Ca from the bone was still at the increased level. (auth)

21423 EXPERIMENTAL ELECTROCARDIOGRAPHIC STUDY ON THE RADIO-INDUCED HEART REACTIVITY. I. PRECORDIAL IRRADIATION WITH A SINGLE DOSE. De Serio, N.; Mezzina, G.; Triggiani, G. (Univ., Bari, Italy). Radiol. Med., 53: 884-90(Sept. 1967). (In Italian).

Rabbits were given a single dose of x radiation administered to the heart at varying distances. Electrocardiograms, taken over a period of one month, showed the following changes: QRS wave lowered in voltage; ST wave increased or decreased; T wave negative in some cases, positive and symmetric branches with sharp points in others. In some cases these modifications disappeared and in others they persisted for the 30-day period. The significance of the study lies in the response of the heart to small doses of radiation. (TSS)

21424 PHOTOREACTIVATION OF DEOXYRIBONUCLEIC ACID. Castellani, A. (CSN, Rome). Ann. Ital. Dermatol. Clin. Sper., 19: 134-45(1965). (In Italian). (RT/BIO-(67)4).

The chromatographic analysis of ^{32}P-labeled DNA irradiated at 260 mμ and treated with snake venom phosphodiesterase allows the separation of all radiation induced photoproducts. Owing to their reduced mobilities, they can be separated from the 5'-deoxyribomononucleotides obtained through enzymatic hydrolysis. The radiochromatography of ^{32}P-labeled DNA after irradiation and photoreactivation shows some radioactivity corresponding to the migration zone of the photoproducts. This demonstrates that not all the uv damage is photoreactivable. It is suggested that the remaining damage after photoreactivation is represented by nonphotoreactivable pyrimidine dimers. Experiments with ^{3}H labeled DNA after irradiation and formic acid hydrolysis allow the isolation of simple or mixed thymine dimers. Under these conditions the chromatography of DNA before and after photoreactivation shows that the radioactivity corresponding to the dimers (Rf. 0.7) completely disappears upon photoreactivation. Since all thymine dimers are photoreactivable, it is concluded that the nonphotoreactivable products of uv irradiated DNA are not thymine dimers. (auth)

21425 CHROMATOGRAPHY OF PRODUCTS OF IRRADIATED ERGOSTEROL. PART II. COLUMN CHROMATOGRAPHY OF 3,5-DINITROBENZOIC ACID ESTERS OF ERGOSTEROL AND VITAMIN D_2. Tulecki, Jerzy; Adamczewska, Zofia (Medical Academy, Poznan, Poland). Poznan. Tow. Przyj. Nauk, Wydzial Lek., Pr. Kom. Farm., 3: 121-8(1965). (In Polish).

Separation and identification of products resulting from the uv irradiation of ergosterol are reported. A mixture of 0.1 g 3,5-dinitrobenzoate of ergosterol and 0.1 g 3,5-dinitrobenzoate of vitamin D_2 was separated on a column of Al_2O_3 that was activated to degree I of activity; the column was water saturated at levels of 1, 3, or 5%. With anhydrous Al_2O_3 or Al_2O_3 containing 1 or 3% water, in addition to the pure 3,5-dinitrobenzoic acid esters of ergosterol and vitamin D_2, mixed fractions of the esters were obtained and rechromatographed. With Al_2O_3 of degree I activity and saturated at 5%, separation was sharp and there was no need to repeat the process. (BBB)

21426 SMALL DOSES OF ULTRAVIOLET IRRADIATION AND THE FORMATION OF THYMINE AND CYTOSINE-THYMINE DIMERS AND THE INFLUENCE ON THE SYNTHESIS OF DNA IN MAMMALIAN CELLS. Klimek, M.; Vlasinova, M. (Inst. of Biophysics, Brno). Cesk. Fysiol., 16: 156-7(Mar. 1967). (In Czech).

Biologically interesting doses are those up to 200 ergs per square millimeter; at higher rates, survival is limited. Ultraviolet irradiation decreased the ability of cells to synthesize deoxyribonucleic acids; a dose of 25 erg/mm^2 reduced the ability to 84.7%, 100 erg/mm^2 to 78%, and 200 erg/mm^2 to 73%. (JPRS)

21427 RESPONSE OF SELECTED SERUM ENZYMES FOLLOWING EXPOSURE TO VARYING DOSES OF FISSION-SPECTRUM NEUTRON AND 250 kVp X-RAY IRRADIATION. Quaife, Merton A. (Omaha Veterans Administration Hospital); Ogborn, Richard E.; Odland, Lawrence T. J. Occup. Med., 9: 103-10 (Mar. 1967).

The effect of ionizing radiation upon the mechanisms that released the enzymes from the intracellular compartment was most prominent in radiations with a linear-energy transfer greater than the baseline x irradiation. The alterations in these parameters of radiation effect were evident even though the relative production of lethality, dose for dose, was greater in x-irradiated subjects. The primary contributing factor to this finding was the difference in depth-dose distribution of the radiation type. Although there was a clear cut difference in the response in enzyme levels studied, based on the type of radiation, no pattern emerged within groups to relate specific dose ranges to either magnitude of response or the time of occurrence following exposure. 8 figures. 13 references. (auth)

21428 STUDY OF THE EFFECT OF IONIZING RADIATION ON THE PHYSIOLOGICAL ACTIVITY OF AZOTOBACTER. Wang, Shu-chin; Wang, Tsu-fang. Wei Sheng Wu Hsueh Pao, 8: 446-54(Dec. 1962). (In Chinese).

Azotobacter is sensitive to γ rays, especially Azotobacter vinelandii No. 230. Forty percent of the cells of Azotobacter vinelandii No. 230 were killed by 5 KR irradiation, and 80% of the cells by 20 KR. Azotobacter chroococcum No. 3 is more resistant to γ rays than Azot. vinelandii No. 230. With irradiation by 5 KR, 5% of the Azotobacter chroococcum No. 3 cells were killed, and with 20 KR irradiation, 34% of the cells. Reproduction capability of the Azotobacteria decreased after irradiation with various dosages of γ rays. The primary dehydrogenases, that play an important role in the tricarboxylic acid cycle, were disturbed. The ability of Azotobacter cells to perform nitrogen-fixing from the air, to assimilate phosphorus and to synthesize protein decreased after irradiation. On the contrary, after irradiation the amount of sugar used in a single cell decreased, internal respiration increased, the quantity of oxygen used by the cells and the quantity of CO_2 released both increased, but the respiration coefficient remained unchanged. After irradiation, the physiological activity of some cells of Azotobacter and their metabolism were inhibited. Some cells were inhibited to a significant degree, and others were little inhibited. Some cells were killed after irradiation, and conversely, a stimulating effect appeared at times with a small dosage. It can be said that each cell has a sensitive and a less sensitive mechanism of the biochemical system. (auth)

21429 KINETICS OF ^{32}P ACCUMULATION AND DETERMINATION OF THE DOSE IN THE BRAIN BY BREMSSTRAHLUNG. Belugina, Z. T.; Kachur, L. A.; Lapchenkov, V. I. (Central Research Inst. of Roentgenology and Radiology, Moscow). Med. Radiol., No. 9, 16-21(Sept. 1966). (In Russian).

Maximum concentrations of ^{32}P in the brain of 18 patients with polycythemia vera were noted in most cases within 48 hours of oral administration of the isotope. The rate of ^{32}P accumulation in the brain was slower than in other organs due both to redistribution of the isotope in the body and to peculiarities in the permeability of the blood-brain barrier. The amount of ^{32}P in the brain was about 20 to 30% that in the liver. A higher content was found in the patients with severe hypertension or other vascular disorders. (auth)

21430 GENERAL NONSPECIFIC IMMUNOLOGICAL REACTIVITY IN WORKERS CHRONICALLY EXPOSED TO IONIZING RADIATION. Gribova, I. A. (Inst. of Industrial Hygiene and Occupational Diseases, Moscow). Med. Radiol., No. 9, 74-8 (Sept. 1966). (In Russian).

General immunological reactivity was studied in persons chronically exposed to doses of ionizing radiation four to five times in excess of maximum permissible values and in those working under conditions close to or below the permissible levels. The author used as a criterion of reactivity the response to subcutaneous injection of antihuman serum (normal rabbit serum immunized by human tissues) in the form of reddening at the injection site. No reddening at all or reddening covering an area less than 1 cm in diameter was considered negative or doubtful and an indication of decrease in general immunological reactivity. The results of the tests showed a substantial number of negatives and doubtfuls among those exposed over a long period of time to above permissible radiation doses and only positives among those exposed to low, permissible doses. (auth)

21431 PROBLEMS OF RADIOIODINE-MONITORING BY DIRECT AND INDIRECT METHODS. Brunner, H. (Eidgenoessisches Inst. fuer Reaktorforschung, Wuerenlingen, Switzerland). pp 559-68 of Radiation Dose Measurements. Their Purpose, Interpretation, and Required Accuracy in Radiological Protection. Paris, European Nuclear Energy Agency, 1967.

From Symposium on Radiation Dose Measurements, Their Purpose, Interpretation, and Required Accuracy in Radiological Protection, Stockholm. See CONF-670621.

The intermittent leakage of ^{131}I from a glove box during a certain infrequent stage in a labeling operation caused the repeated intake of radioiodine by several technicians in a hot laboratory. For about half a year, until the faulty component could be located, over sixty cases of single intakes of ^{131}I were followed by several monitoring methods (continuous air monitors with moving filters; air samplers with special iodine filters which were measured daily; direct measurements of activity in the thyroid with a collimated 3 × 3 in. NaI-scintillator; whole-body counting; daily urine analysis by direct scintillation counting of sample bottles and by measurement of β-activity after radiochemical iodine separation). Each case was followed as long as possible. Only in one case, and then only for a few days, did the thyroid activity exceed the permissible level. It was concluded that air monitors, air samplers, and other area and contamination monitors can be very useful as indicators of a leakage or the possibility of a personnel exposure, but local concentration variations in a room can be so large, that no correlation can be found between activity levels indicated by the monitors and the activities actually found in the thyroids and bodies of the exposed persons. Personnel monitoring should be done by two independent methods. Direct control of the thyroid activity with a special scintillation probe is fast and sensitive, but errors may be introduced by persistent skin contamination, iodine activity in other parts of the body, as well as in cases of thyroid malfunction or blocking, where the body may contain large amounts of radioiodine although none can be detected in the thyroid. Whole-body counting or urine analysis may be used as supplementary methods. Comparison of direct thyroid measurements and iodine excretion in the daily urine showed that in the period between one and ten days after a single intake the daily urinary excretion rate averages 10 ± 5% of the thyroid activity present. The values found in literature (about 0.1% per day) are too low. An investigation level of 1400 pCi/daily urine was adopted, corresponding to $1/10$ of the expected daily urinary excretion when the thyroid contains the permissible activity of 0.14 μCi. (auth)

21432 RELATIVE BIOLOGICAL EFFECTIVENESS OF INTERMEDIATE-ENERGY NEUTRONS (BASED ON PHAGE INDUCTION). Troitskii, N. A.; Bylinskii, A. F. pp 3-7 of Vliyanie Ioniziruyushchikh Izluchenii na Nasledstvennost'. Dubinin, N. P. (ed.). Moscow, Izdatel'stvo Nauka, 1966. (In Russian).

Results are reported from a study of the RBE of intermediate neutrons (1 to 500 keV) with respect to the induction of phage in a lysogenic strain of Escherichia coli. A maximum value of the RBE of intermediate neutrons and gamma rays for phage induction in the lysogenic strain of E. coli equal to 45 was derived. This value was not unexpected since the RBE reaches a maximum in the intermediate energy range of neutrons, the RBE of neutrons with an energy of 50 keV being an order higher than for fast neutrons. (ATD)

21433 EFFECT OF IONIZING RADIATION ON THE DNA CONTENT IN CELL NUCLEI OF RADIOSENSITIVE AND RADIORESISTANT TISSUES. Ivanov, I. I.; Borovikova, O. N.; Vladimirov, V. G.; Dolgo-Saburov, V. B.; Sharobaiko, V. I. pp 85-92 of Vliyanie Ioniziruyushchikh Izluchenii na Nasledstvennost'. Dubinin, N. P. (ed.). Moscow, Izdatel'stvo Nauka, 1966. (In Russian).

The drop in the content of DNA in the nuclei of small lymphocytes in the liver and spleen of white rats after total-body single doses of radiation of 300 and 1000 R was found to depend on a drop of DNA level only in the nuclei of cells with a disturbed functional state. This was demonstrated by their red fluorescence in the presence of acridine orange. The results also indicated definite disorders in the character of DNA localization in the nuclei of cells with red fluorescence, which was characterized by a change in the magnitude of the coefficient of DNA accumulation in nuclei. The DNA content in cells that retained a green fluorescence after irradiation did not change. The difference in the content of DNA in the viable, green-fluorescing cells and the dead red-fluorescing cells was more pronounced in the case of radiosensitive tissues (spleen) and was demonstrated to a lesser degree in radioresistant tissues (liver). This phenomenon is possibly explained by a difference in the extent of depolymerization of DNA in both cases and also by a difference in the rate of escape of its depolymerization products through the nuclear membrane. (ATD)

21434 FREE CHOLINE LEVEL CHANGES OF THE LIVER IN RATS IRRADIATED WITH HIGH-ENERGY PROTONS, GAMMA RAYS, AND FISSION NEUTRONS. Kudryashov, Yu. B.; Arutyunova, O. S. Nauch. Dokl. Vyssh. Shk., Biol. Nauki, No. 2, 58-60 (1967). (In Russian).

White male rats weighing 120 to 150 g were irradiated with single doses of different types of ionizing irradiation corresponding to 300, 700, and 1500 R. High energy protons (660 MeV, synchrocyclotron), fission neutrons (IBR type atom reactor), and gamma rays (GUBE-^{60}Co-800 unit) were used. Free choline levels of the liver were determined by a spectrophotometric method at periods ranging from 30 min to 9 days following irradiation. Findings show that equivalent doses of different types of irradiation induce similar choline level changes in the liver. A 300 R dose did not induce any reliable changes and a 700 R dose induced a form of radiation injury more extended in time than a 1500 R dose. Choline level changes were found for all the radiation doses. The first phase, marked by an increase of the choline level, was characteristic of the early period of radiation injury. The second phase, marked by a decrease of the choline level, was observed on the 2nd day following a 1500 R dose and on the 3rd day following a 700 R dose. Apparently, the decrease of choline level is not an index of the degree of radiation injury. Dependence of the choline level on radiation dose was found only in the phase of choline level increase. Thus, in the first phase the choline level increased by 25 to 34% following a 700 R dose and increased by 40 to 50% following a 1500 R dose. The third phase was marked by a second increase taking place during the 2nd week. Even with acute forms of radiation injury, the free choline level of the liver increased by only one and a half times compared to the normal. The concentration of choline toxic for rats is considerably higher than the level found in animals with radiation injury. Thus, increase of choline is not the cause of complex radiation toxic effects. (ATD)

21435 STUDIES ON RADIATION RENAL DAMAGES. II. RADIOISOTOPE RENOGRAM FOLLOWING X-RAY IRRADIATION IN EXPERIMENTAL SOLITARY KIDNEY OF ADULT DOG. Miroguchi, Masaru (Hiroshima Univ.). Hinyokika Kiyo, 12: 1065-77 (Oct. 1966). (In Japanese).

Various doses of x radiation were administered to the left kidney of 18 Mongolian dogs weighing 10 to 17 kg following right nephrectomy. Controls consisted of intact dogs in which the left kidney was irradiated. Survival time was about the same in both groups. Renograms of the left kidney of the nephrectomized group showed marked hyperfunctioning for two to three days after irradiation and later hypofunctioning corresponding to radiation dose. Hypofunctional changes appeared earlier in the control group; it was thought that compensatory hypertrophy of the left kidney in the nephrectomized group accounted for the delayed appearance of hypofunctioning in this group. (NSA of Japan) (TSS)

21436 SIGNIFICANCE OF FLUORESCENT MICROSCOPY IN DIAGNOSIS OF URANIUM POISONING. T'ao, Hsueh-hsun; Yen, Shu-chen Yuan Tzu Neng, No. 11, 988-90(1965). (In Chinese).

Fluorescence microscopy techniques were used to study changes in leukocytes of the peripheral blood in 35 rabbits following intraperitoneal injection of $UO_2(NO_3)\cdot H_2O$ at a dose of 1 mg/kg. Observations were made at intervals until the 30th day following injection. Intoxication symptoms appeared on the third day and were manifested by a decrease in the mobility of animals and refusal to eat, as well as by the appearance of nasal discharge and decrease of diuresis. Twenty-two rabbits died between the fourth and eleventh day. Normal leukocytes were red with light green nuclei, while pathological leukocytes are yellow-red in color. A gradual decrease in the number of normal leukocytes and increase in the number of pathological leukocytes occurred, reaching maximum levels by the fourth day. By the eighth day the

condition of the animals improved; the number of normal leukocytes reached 78.4% and returned to normal by the 19th day. The total number of leukocytes did not change. It was thought that metabolic changes in the RNA and DNA of leukocytes resulted in the death of some cells. (JPRS) (TSS)

21437 METABOLIC PROCESSES INVOLVED IN THE DEVELOPMENT OF NUCLEAR PYKNOSIS IN IRRADIATED RAT THYMOCYTES. Scaife, J. F.; Brohee, H. (EURATOM, Ispra, Italy). Int. J. Radiat. Biol., 13: 111-36(1967).

The development of nuclear pyknosis in x-irradiated rat thymocytes was shown to be closely correlated with the intracellular labilization of DNA from their nucleoprotein. The development of pyknosis was completely dependent on the respiratory activity of the cell. It was prevented or slowed by any metabolic inhibitor which retarded the respiration of the cell. It was not dependent on the level of ATP within the cell and could be prevented by inhibitors which produce a high intracellular level of inorganic phosphate. The development of nuclear pyknosis was however, accelerated by high concentrations of phosphate and by serum. Intracellular phosphate facilitates the dissociation of DNA from the damaged nucleoprotein. There was no evidence for increased levels of inorganic phosphate or phosphate uptake, by irradiated cells. There was evidence for damage to the respiratory mechanism of the irradiated cell. Large thymocytes which took up $^{3}H-$ TdR were more resistant to irradiation than smaller unlabeled cells. Regenerating, newly-formed thymocytes were more sensitive to irradiation than the normal equilibrium population of the thymus. (auth)

21438 RELATIVE ABSORPTION OF STRONTIUM AND CALCIUM BY CERTAIN ALGAE. Fuller, Wallace H.; Hardcastle, James E. (Univ. of Arizona, Tucson). Contract AT(11-1)-947. Soil Sci. Soc. Amer., Proc., 31: 772-4(Nov.-Dec. 1967).

The relative uptake of strontium-90 and calcium was compared, using seven different species of algae (A. falcolus var. acicularis, Scenedesmus, sp., Pediastrum sp., Sphaerocystis sp., Phormidium sp., Nostoc sd., and Anabaena sp.,) isolated from fresh water and arid land. Uptake always favored calcium over strontium when the two elements were present in nutrient media together. Strontium was absorbed in addition to the calcium requirement. With Scenedesmus sp., however, strontium actually appeared to compete with calcium. (auth)

21439 PROLONGATION OF SKIN HOMOGRAFT SURVIVAL BY LOCAL INTRALYMPHATIC RADIOISOTOPE INJECTIONS. Szabo, G.; Magyar, Szusza; Balint, J. (National Inst. of Traumatology, Budapest). Experientia, 24: 70-1(Jan. 15, 1968).

Rabbits received intralymphatic injections of ^{111}Ag colloid and ^{131}I-lipiodol in the right ear. Twenty-four hours after the injection a skin homograft was made on the injected right ear. The skin flap removed from the right side onto the left ear of the same animal. In the controls the grafting procedures were duplicated without isotope injection. The homografts were rejected in the controls on the seventh to ninth day; the rejection was substantially delayed in the injected animals. In studies on distribution of radioisotopes injected intralymphatically it was found that about 50% of the ^{111}Ag colloid, but less than 10% of the ^{131}I-Lipiodol was absorbed by the lymph node regions, and that the ^{131}I-Lipiodol accumulated chiefly in the lung tissue, while the ^{111}Ag colloid accumulated chiefly in the liver. (H.L.W.)

21440 TISSUE CULTURE OF PRIMITIVE HUMAN MYELOID CELLS FOR THE STUDY OF CELLULAR PROLIFERATION. PRELIMINARY REPORT ON A GROWTH INHIBITOR IN THE HEATED SERUM OF TWO PATIENTS WITH CHRONIC MYELOGENOUS LEUKEMIA (CML) FOLLOWING SPLENIC IRRADIATION. Shohet, Stephen B.; Gardner, Frank H. (Peter Bent Brigham Hospital, Boston). Blood, 31: 180-7(Feb. 1968).

Sera from two patients with chronic myelogenous leukemia obtained within one hour after irradiation of the spleen inhibited the growth of a stable cell line derived from the blood of a patient with acute myelogenous leukemia. This inhibitory factor was stable in vitro for one half hour at 55°C and for 3 days at −80°C. Serum from a patient with metastatic carcinoma of the breast following thoracic irradiation did not have a similar effect. (auth)

21441 INHIBITION OF LIPOLYSIS AND LIPOGENESIS BY ULTRAVIOLET RADIATION OF ADIPOSE CELLS OF THE RAT. Combret, Yvette; Abelanet, Rene; Laudat, Philippe (Hopital Cochin, Paris). Compt. Rend., Ser. D, 265: 1522-3(Nov. 13, 1967). (In French).

Adipose cells were isolated from rat tissues and exposed to ultraviolet radiation. Spontaneous lipolysis and lipolysis induced by adrenaline were determined at intervals from one to 30 min. Incorporation of ^{14}C-labeled glucose was measured in total lipids, triglycerides, and carbonic anhydride. During the irradiation, the two phenomena of lipolysis and lipogenesis passed through excitation and inhibition phases. Spontaneous lipolysis was not affected by radiation. However, lipolysis induced by adrenaline was at first stimulated with a maximum at 10 min, then rapidly inhibited between 15 and 25 min. It was concluded that 25 min of irradiation inhibited completely the activation of adrenaline-sensitive lipase. The incorporation of glucose diminished rapidly between 15 and 30 min, but after 35 min was even more significantly reduced. (H.L.W.)

21442 A RADIOASSAY FOR SERUM B_{12} USING UNSATURATED TRANSCOBALAMIN I AS THE B_{12} BINDING PROTEIN. Rothenberg, Sheldon P. (New York Medical Coll., N. Y.). Blood, 31: 44-54(Jan. 1968).

A radioisotopic assay for serum vitamin B_{12} is described based on the fact the unlabeled B_{12} will competitively inhibit the binding of $^{57}CoB_{12}$ to a specific B_{12} binding protein, transcobalamin I. This protein is stable in dilute solution and at the concentration of $^{57}CoB_{12}$ used for the assay, its binding capacity increases much less than IF or normal serum as the concentration of B_{12} increases in the reaction mixture. Because of the stability of the binding capacity of stored frozen TC-I containing serum, only a single standard curve need be established with each lot of binding protein. When a limited quantity of TC-I is incubated with 60 pg of $^{57}COB_{12}$ and crystalline B_{12} concentrations ranging from 10 to 160 pg/ml, a linear standard curve is obtained when the reciprocal of the fraction of $^{57}COB_{12}$ bound to TC-I is plotted as a function of unlabeled B_{12} concentration. This permits use of a simple arithmetic expression to determine the B_{12} concentration of unknown extracts after experimentally determining the fraction of $^{57}COB_{12}$ bound to TC-I. The serum B_{12} concentration of 25 normal subjects ranged from 154 to 674 pg/ml while the range in 15 B_{12} deficient patients was 0−126 pg/ml. The B_{12} concentration in four patients with chronic myelogenous leukemia was greater than 1000 pg/ml. The mean variance of 15 serum extracts frozen and reassayed several weeks later was 7.4 per cent. The range of recovery of B_{12} added to serum extracts was 84−118 per cent. (auth)

21443 EVALUATION OF CERTAIN PROPERTIES OF RADIOCERIUM AS AN INDIGESTIBLE MARKER. Huston, J. E.; Ellis, W. C. (Texas A and M Univ., College Station). J. Agr. Food Chem., 16: 225-30(Mar.-Apr. 1968).

Five experiments were conducted to study the affinity of ^{144}Ce for feedstuff and digested particles under in vitro conditions simulating the intraruminal environment. The collective results indicated radiocerium was rapidly adsorbed on and remained tenaciously bound to digested particles, and might therefore be expected to move through the rumen in association with particles resulting in a low variation in its fecal concentration. When fed mixed with the ration, radiocerium was excreted with less variation than was either polyethylene glycol or chromic oxide. (auth)

21444 THE CONTENT OF α-GLYCEROPHOSPHATE IN MOUSE LIVER AFTER WHOLE-BODY X-IRRADIATION. Berndt, Jurgen (Univ., Freiburg i.B.). Int. J. Radiat. Biol., 13: 187-8 (1967).

Male white mice were fed with standard food or fasted for 24 hours before killing. Mice were x irradiated with 690 R (145 R/min), and the liver was removed. The content of α-glycerophosphate in the liver of fed mice was 0.89 ± 0.05 μmoles per g wet liver tissue, and in 24-hour starved mice was 0.37 ± 0.03 μmoles/g. After whole-body x irradiation with 690 R, the content decreased rapidly in fed mice. However, this change depended to a high degree on the irregular food intake after irradiation. The content of α-glycerophosphate rose up to almost normal values from the 5th to 11th day after irradiation, and this increase coincided with a normal food intake. The influence of irregular food intake was studied in a second series in which the content of α-glycerophosphate was determined in the liver of mice fasted for 24 hours before being killed. At the time of killing, all mice were therefore in the same nutritional state. Under these circumstances, the content of α-glycerophosphate increased on the first day after irradiation and continued to increase for all 16 days measured. On the 13th to 16th days after irradiation, the level of α-glycerophosphate had increased almost 100% above the normal value. It was concluded that the increase of α-glycerophosphate might be connected with an enhanced lipid degradation after irradiation, and therefore represent an additional source of glucose precursors. (C.H.)

21445 ON THE MECHANISM OF RADIOSENSITIZATION BY IODINE COMPOUNDS AT THE MOLECULAR LEVEL. Quintiliani, M.; Bernardini, L. (Istituto Superiore di Sanita, Rome). Experientia, 23: 630-1(Aug. 15, 1967).

Alcohol dehydrogenase from yeast was x-irradiated, and it was found that inactivation of the enzyme was logarithmically related

to the dose of radiation. 3-Iodopropionic acid and methyl iodide were tested for their radiosensitizing effects on alcohol dehydrogenase and results are tabulated. In other studies, alcohol dehydrogenase was irradiated in solutions containing ^{131}I-labeled-sodium iodide. After separation from the radioactive solution, no radioactivity was found in the enzyme. (H.L.W.)

21446 AUTOIMMUNE PROCESS IN ACUTE RADIATION SICKNESS AND THE EFFECTS OF ANTIBIOTICS ON ITS DEVELOPMENT. Mil'man, M. Sh.; Nikolaev, A. I.; Temirgaliev, A. G. (Research Inst. of Roentgenology, Radiology, and Oncology, Tashkent). Byull. Eksp. Biol. Med., No. 10, 38-41(Oct. 1966). (In Russian).

Rabbits were subjected to 600 R of whole-body x irradiation. They received penicillin, streptomycin, terramycin, or chloramphenicol an hour before exposure and then daily for 30 days. The effects of the antibiotics on autoimmunization during the acute radiation sickness was judged from the titer of autoantibodies in the liver, kidneys, spleen, lymph nodes, intestine, heart, and blood vessels. Within a week of irradiation, antibodies were found in the liver, intestine, spleen, and lymph nodes. During the second week the autoantibody titer increased sharply. The highest titer was noted with antigens from the liver and lymph nodes, i.e., organs with defense functions. The titer decreased on the thirtieth day of the experiment, but remained comparatively high for organs with barrier functions. The antibiotics did not prevent the development of autosensitization caused by the x rays. However, they markedly suppressed the formation of autoantibodies to various organs as compared with the control animals. Moreover, the antibody titer decreased more rapidly in the irradiated animals that received antibiotics than it did in the control. (auth)

21447 EFFECT OF HIGH DOSE OF ^{60}Co GAMMA RAYS ON POTATO STARCH. Traubenberg, S. E.; Korotchenko, K. A.; Putilova, I. N. (Moscow Technological Inst.). Izv. Vyssh. Ucheb. Zaved., Pishch. Tekhnol., No. 6, 24-8(1965). (In Russian).

In continuation of earlier work with lower doses of 1500 R/min, a total of 18 to 94 mrad was applied to commercial starch containing 16% moisture, placed in closed ampoules in the presence of air at room temperature. Changes were recorded spectrophotometrically in the ultraviolet and visible ranges. Further determinations included color, amount of reducing substances (iodometry), mean molecular weight (according to end groups), solubility (by refractometer), pH, organic acids, formaldehyde (spectrum), glucose and maltose (paper chromatography). Results showed an increase of destructive processes with increased gamma doses resulting in a weakened structure of the grain which becomes brittle, increase in water-soluble substances (655 fold at 94 mrad) due probably to rupture of the 1–4 and 1–6 glucoside bonds, and appearance of aldehyde end groups. No glucose or maltose were detected. Solubility was higher in the 18 to 56 mrad interval than at higher doses. Decrease of pH and increase of organic acids, hydrogen ions and carboxy groups was highest at 47 to 56 mrad. Decrease in optical density paralleled color changes determined with iodine. The absorption maximum at 260 to 265 mμ was indicative for dioxyacetone. It was concluded that at the above doses, just as at doses below 18 mrad, starch depolymerization will lead to the formation of dextrine-like substances. The radiation induced chemical transformation is accompanied by formation of low molecular compounds: acids, dixoyacetone and formaldehyde. No mono- or disaccharides were formed. The values of dissociation constants approximated those of some carboxy-acids such as glycolic, gluconic, and mucic. The irradiated starch retained free radicals for a long time; these probably represent an intermediate step in radiolytic molecular degradation. (ATD)

21448 MOLECULAR COMPOSITION OF MYELIN SYNTHESIZED SUBSEQUENT TO IRRADIATION. Schjeide, Ole A.; Lin, Robert I-San; de Vellis, Jean (Univ. of California, Los Angeles). Radiat. Res., 33: 107-28(1968).

Myelin was isolated from brain stems of control rats and their head-irradiated littermates (700 rads at 2 days of age). Rats were sacrificed at 20, 30, 40, and 180 days of age. Much less myelin was found to be deposited in brain stems of head-irradiated rats as compared to controls. However, within experimental error, no differences were ascertained, as functions of either age or irradiation, in major building blocks of myelin. These include total protein, total sterol, phosphatidyl serine, sphingomyelin, phosphatidyl choline + lysophosphatidyl choline, phosphatidyl ethanolamine + phosphatidyl ethanolamine, and cerebroside + cerebroside sulfate. However, the proportions of all normal unsaturated fatty acids in myelin from irradiated rats were lower with respect to their saturated counterparts than in control myelin. Markedly lower ratios of both monounsaturated C24 acid and monounsaturated C26 fatty acid to their saturated counterparts were noted, and the proportion of total C26 to total C24 fatty acids was less. In fact, longer-chain-length fatty acids were generally present in smaller amounts in irradiated myelin. Similar differences in proportions of myelin fatty acids occur normally among varying age groups. Myelin from more mature animals contains higher proportions of unsaturated fatty acids and higher proportions of the longer-chain-length fatty acids than myelin from younger animals. These observations are consistent with the view that x irradiation given to the head at an early age prevents the normal biochemical differentiation of the glial cells giving rise to myelin. (auth)

21449 THE TOXICOLOGY OF RADIOACTIVE SUBSTANCES. VOLUME 3. ^{59}Fe. Letavet, A. A.; Kurlyandskaya, E. B. (eds.). New York, Pergamon Press, 1967. 193p. $9.00.

Translated from Toksikologiya Radioaktivnykh Veshchestv by R. E. Travers.

Experimental results of studies on toxicity of radioactive iron conducted by the Radiotoxicity Laboratory of the Institute of Occupational Hygiene and Disease, Academy of Medical Sciences, U.S.S.R. are reported. Separate abstracts were prepared for 16 chapters. (C.H.)

For abstracts of individual chapters see: 21450–21456 and 21598–21606.

21450 TOXICOLOGY OF RADIOACTIVE ^{59}Fe. Kurlyandskaya, E. B. pp 1-10 of The Toxicology of Radioactive Substances. Vol. 3. Letavet, A. A.; Kurlyandskaya, E. B. (eds.). New York, Pergamon Press, 1967.

Rabbits were given oral doses of $^{59}FeCl_3$ of 1μCi/kg body weight that produced a mean whole-body dose of mixed β and γ radiation of about 0.04 rads/day, doses of 10μCi/kg body weight that produced a whole-body dose of about 0.3 rads/day, or stable Fe at doses of 1 to 4 mg/kg body weight. Observations over a period of 21 months showed that animals on a normal diet absorbed only about 5% of the $FeCl_3$ through the intestinal tract, and the remainder was excreted in feces during the course of a week. The half-life of Fe in the blood was found to be about 200 days. A fairly constant level of ^{59}Fe in hematopoietic tissue was observed after 45 to 65 days. It was concluded that changes in erythropoiesis observed after administration of ^{59}Fe were the result of combined radiation and chemical effects. Individual sensitivity to ^{59}Fe was demonstrated by the death of some animals during the first few months after administration. Morphological examination of tissues showed functional disturbances in bone marrow. Rats given intratracheal injections of 1.06, 3.36, or 27.5 μc of insoluble ^{59}Fe oxide or 20 μc soluble ^{59}Fe citrate per rat were found to retain insoluble Fe in the lungs for a long period of time, while distribution of soluble ^{59}Fe citrate in body tissues was observed after the first day. No carcinogenic effect of ^{59}Fe oxide was observed during a 15-month period. Both CDTA and EDTA caused increased excretion of ^{59}Fe in the urine when administered soon after the dose of ^{59}Fe. (C.H.)

21451 DISTRIBUTION AND EXCRETION OF DIFFERENT RADIOACTIVE IRON (^{59}Fe) COMPOUNDS AFTER INTRATRACHEAL INJECTION IN WHITE RATS. Sagaidak, N. D. pp 11-18 of The Toxicology of Radioactive Substances. Vol. 3. Letavet, A. A.; Kurlyandskaya, E. B. (eds.). New York, Pergamon Press, 1967.

Results of tracer studies on the distribution of insoluble and soluble Fe compounds in the tissues of rats following intratracheal injection in $^{59}Fe_2O_3$ powders or in a solution of ^{59}Fe citrate are reported. Tissues obtained at various times from one hr to 20 days following injection of ^{59}Fe were analyzed. Most of the powdered $^{59}Fe_2O_3$ remained at the injection site, but small amounts were excreted in sputum. Most of the ^{59}Fe citrate solution was absorbed from the lungs during the first few days after injection. Iron-59 accumulated in the liver, bone marrow, and blood, and was excreted in feces and urine. (C.H.)

21452 BODY RADIATION DOSE IN RABBITS PRODUCED BY DAILY ORAL ADMINISTRATION OF $^{59}FeCl_3$, AND SOME DATA ON ACCUMULATION AND EXCRETION OF ^{59}Fe. Avrunina, G. A. pp 19-37 of The Toxicology of Radioactive Substances. Vol. 3. Letavet, A. A.; Kurlyandskaya, E. B. (eds.). New York, Pergamon Press, 1967.

The distribution and excretion of ^{59}Fe were determined in rabbits following the chronic oral administration of $^{59}FeCl_3$ in daily doses of 10μCi/kg or 1μCi/kg. The γ radiation dose in various body tissues, blood, and feces was measured as a function of the accumulation of ^{59}Fe in the body and the amount of carrier in the solution. Measurements were made externally and in blood samples by means of a calibrated γ probe. Calculation of in vivo radiation doses from data obtained by external measurements and repeated measurements of blood radioactivity is described. (C.H.)

21453 CHANGES IN ERYTHROPOIESIS DURING PROLONGED ADMINISTRATION OF ^{59}Fe. Ponomareva, V. L. pp 61-72 of The Toxicology of Radioactive Substances. Vol. 3. Letavet, A. A.; Kurlyandskaya, E. B. (eds.). New York, Pergamon Press, 1967.

The effects of prolonged administration of ^{59}Fe on erythropoiesis were studied in rabbits given $^{59}FeCl_3$ in daily doses of 1 μci/kg or 10 μci/kg body weight. Measurements of erythrocyte cell size and osmotic fragility as well as hemoglobin content and morphology, were used as indications of changes in erythropoiesis during a 13-month period. Administration of the smaller doses of ^{59}Fe resulted in a stimulation of erythropoiesis during the first month, followed by impairment in erythropoiesis. The larger dose of ^{59}Fe resulted in a series of early quantitative changes in the erythrocyte precursors in the bone marrow that led to changes in morphology and increased hemoglobin content of erythrocytes in the peripheral blood. (C.H.)

21454 HAEMOPOIESIS AFTER BLOODLOSS IN RABBITS DURING PROLONGED ADMINISTRATION OF ^{59}Fe. Beloborodova, N. L.; Red'kina, E. K.; Ponomareva, V. L. pp 73-84 of The Toxicology of Radioactive Substances. Vol. 3. Letavet, A. A.; Kurlyandskaya, E. B. (eds.). New York, Pergamon Press, 1967.

The effects of ^{59}Fe, administered over a 7-month period, on recovery of hematopoiesis following artificial hemorrhage are reported. Blood losses following the administration of daily doses (10μCi/kg body weight) equaled 1% of the body weight. Comparison of results of similar studies on animals that had received a similar dose of stable Fe and on control animals showed no effects in peripheral blood. Animals receiving ^{59}Fe showed a decrease in erythrocyte cell count of about 25% and a decrease in hemoglobin content of about 20% on the first day after hemorrhage. The number of leukocytes in peripheral blood was increased on the first day after loss of blood but decreased during the following 4 to 10 days. Regeneration of hematopoiesis was also retarded in these animals. (C.H.)

21455 THE EFFECT OF THE CALCIUM DISODIUM SALT OF CYCLOHEXANE-DIAMINOTETRA-ACETIC ACID [$CaNa_2$-(CDTA)], THE CALCIUM DISODIUM SALT OF ETHYLENE-DIAMINOTETRA-ACETIC ACID [$CaNa_2$(EDTA)], AND PECTIN ON DISTRIBUTION AND EXCRETION OF ^{59}Fe. Rubanovskaya, A. A. pp 173-83 of The Toxicology of Radioactive Substances. Vol. 3. Letavet, A. A.; Kurlyandskaya, E. B. (eds.). New York, Pergamon Press, 1967.

The effects of pectin, and the calcium disodium salts of both CDTA and EDTA on the excretion of ^{59}Fe in rats were investigated. Pectin had no effects, whereas both CDTA and EDTA increased ^{59}Fe excretion. (C.H.)

21456 POLYVINYLPYRROLIDONE AND EXPOSURE TO CERTAIN RADIOISOTOPES. Rubanovskaya, A. A. pp 184-8 of The Toxicology of Radioactive Substances. Vol. 3. Letavet, A. A.; Kurlyandskaya, E. B. (eds.). New York, Pergamon Press, 1967.

Injection of polyvinylpyrrolidone (PVP) directly into the stomach of rats immediately before an oral dose of ^{90}Sr resulted in a 24.8% increase in excretion of ^{90}Sr and a 73.3% decrease in the amount deposited in bone when compared with controls. Injection of a mixture of $CaNa_2$(CDTA) and PVP had no effect on the excretion of ^{59}Fe in rats. (C.H.)

21457 METHODOLOGICAL APPROACHES TO THE STUDY OF LEUKEMIAS. A Symposium held at The Wistar Institute of Anatomy and Biology, Philadelphia, April 5 and 6, 1965. Defendi, Vittorio (ed.). The Wistar Institute Symposium Monograph Number 4. Philadelphia, The Wistar Institute Press, 1965. 233p. $7.50. (CONF-650443).

Separate abstracts were prepared on two papers. One paper was abstracted previously and appeared in NSA Vol. 20 as number one. Twelve additional papers discuss new methodological approaches to studies on the etiology of leukemia and lymphoma. (C.H.)

For abstracts of individual papers see: 21458 and 21550.

21458 INTERFERENCE IN MOUSE LEUKEMIA: RESULTS AND PROSPECTS. Latarjet, Raymond (Institut du Radium, Paris). pp 105-12 of Methodological Approaches to the Study of Leukemias. Defendi, Vittorio (ed.). Philadelphia, The Wistar Institute Press, 1965.

From Wistar Inst. Symposium on Human Leukemias, Philadelphia, Apr. 5-6, 1965. See CONF-650443.

Newborn mice were injected with uv- or x-irradiated cell-free extracts from isologous or homologous mice with virus-induced or x-radioinduced leukemia and the incidence and latent period of leukemia induction was determined. Exposure of the extracts to uv radiation decreased the incidence of leukemia in recipients by 12 to 28% in comparison with controls and x-irradiated extracts decreased the incidence of leukemia in recipients by 30 to 40%. Similar results were obtained when isologous and homologous extracts were injected. Possible mechanisms involved in the anti-neoplastic effects of heavily irradiated cell-free extracts from leukemic mice include indirect interference, steric interference, and immunological effect. (C.H.)

Ecology

Refer also to abstract 21407.

21459 (COO-1156-28) RADIOECOLOGY OF SOME NATURAL ORGANISMS AND SYSTEMS IN COLORADO. Sixth Technical Progress Report, January 1, 1967-December 31, 1967. Whicker, F. W.; Dahl, A. H. (Colorado State Univ., Fort Collins. Dept. of Radiology and Radiation Biology). Feb. 1, 1968. Contract AT(11-1)-1156. 75p. Dep. CFSTI.

It was established that wild mule deer accumulated measurable amounts of fallout radionuclides under environmental conditions existing since 1961. Significant differences in bone ^{90}Sr concentrations were found between different age groups. The higher concentrations were found consistently in the younger age classes in 1962. Calcium determinations on 66 samples of various bones and antlers indicated uniform concentrations. Thyroid levels of iodine-131 showed marked responses to the series of nuclear tests in 1961 and 1962. Age was shown to have a significant effect on the thyroid burdens with the higher levels occurring in the younger age classes. There were no apparent differences between sexes. Cesium-137 concentrations in muscle tissues increased until August, 1963, eight months following the cessation of nuclear tests in 1962. Levels decreased yearly after 1963. The degree of foliage contamination and food habits were shown to be the most important factors contributing to ^{137}Cs burdens in deer. Neither sex nor age produced statistically significant variation in muscle ^{137}Cs. Concentrations of ^{144}Ce, ^{137}Cs, ^{54}Mn, and ^{106}Ru in liver tissues were determined between May, 1963 and August, 1964. Analysis of rumen contents by gamma spectroscopy demonstrated the presence of ^{144}Ce, ^{137}Cs, ^{54}Mn, ^{106}Ru, ^{125}Sb, ^{95}Zr, and ^{90}Sr. These radionuclides were also found in samples of deer forage plants. Summer range plants were higher in nuclide concentrations than winter range species. Comparisons of ^{137}Cs levels between leaves and stems of several deciduous species indicated that leaves were more radioactive per gram than the stems. Radionuclides occurring in fallout debris in air samples were ^{144}Ce, ^{137}Cs, ^{54}Mn, ^{106}Ru, ^{125}Sb, and ^{95}Zr. Iodine-131 and ^{140}Ba were detected for several weeks following atmospheric nuclear testing. Measurable quantities of fallout debris were deposited in rain collectors during both wet and dry periods. Peak levels of deposition occurred during the spring months of each year. Studies on soil radioactivity indicated that the surface contamination generally increased with elevation and rainfall averages. Measurements of climate and fallout concentration were made on four physiographically contrasting sites in a mountainous area. Air and soil temperatures were cooler, diurnal air temperature fluctuations smaller, relative humidity and mean snow depth higher, and precipitation lower, on the timbered north-facing slope. Cesium metabolism studies in mule deer showed no significant difference in elimination between yearlings and adults. Feed intake and body weight were found to greatly affect elimination rates with longer elimination half times being associated with below normal intake and increased body weight. Studies on metabolism of iodine in mule deer were begun. Concentrations of ^{137}Cs in muscle tissue of eight species of game fish were determined in 1965 and 1966. Crappies and trout from plains and foothills reservoirs and lakes contained little or no ^{137}Cs. Trout from alpine lakes and reservoirs contained moderate to high concentrations of ^{137}Cs. (H.L.W.)

21460 (COO-1171-82) FOOD CHAIN TRANSFER OF ^{137}Cs FROM TROPOSPHERE TO MAN. Sixth Annual Report. Ward, Gerald M.; Wilson, Daniel W.; Johnson, James E. (Colorado State Univ., Fort Collins. Dept. of Animal Science). Jan. 15, 1968. Contract AT(11-1)-1171. 106p. Dep. CFSTI.

Atmosphere and atmospheric precipitation in Colorado were analyzed for ^{137}Cs from fallout in 1967. Studies on contamination of feed by fallout include analyses of dairy feeds for ^{144}Ce, ^{137}Cs, ^{40}K, ^{54}Mn, ^{106}Ru, ^{125}Sb, and ^{95}Zr. Milk samples from the University dairy herd were analyzed for ^{137}Cs and K during the period from 1962 to 1967. Analysis of human diet for ^{137}Cs included determinations on cereals, fruits, meats, and milk. Monthly levels of ^{137}Cs were determined in man by whole-body counting. Rates of decrease of body burden were determined using the food level decay constant, daily intake, and biological decay time. The fission products, ^{144}Ce, ^{54}Mn, ^{106}Ru, and ^{125}Sb, were determined in surface air by

gamma ray analysis during the period from 1962 to 1967. Peak values for all radionuclide activities in air in the five yr time span occurred in the spring of 1963, and levels decreased exponentially from the 1963 peaks. A mathematical model for predicting fallout ^{137}Cs in milk was constructed. Factors considered in formulation of the model were description of fallout rate to crops, feeding practices that determine intake, and the transfer from feed to milk. Monthly averages of ^{137}Cs were determined between 1962 and 1967, and the time trends of these levels were analyzed into two components, one describing the buildup of surface air levels that occurred during the fall and winter, and another describing the decrease of surface air levels through spring and summer. The mean half-time for the buildup in surface air was 80 days, while the mean exponential half-time of decay in the second period was 45 days. Deposition velocities for radon daughters on alfalfa were determined and results are tabulated together with wind speed and relative humidity. Calibration of the whole-body counter was done for humans for ^{137}Cs and ^{42}K. Effects of age, height, and weight on results are shown by means of a table. Potassium-40 was used as an indicator for determinations of body composition of cattle and swine. The milk secretion rate of ^{134}Cs was investigated in a lactating cow following an acute ruminal dose of tracer when the cow was in equilibrium with three diets of differing K content. In order to provide data for comparison of turnover rates of ^{134}Cs between species the rate constants for turnover of Cs in a sheep were investigated. Determinations of whole-body ^{137}Cs and K were made on members of the Colorado State University girls swimming team. Body burdens of ^{226}Ra, RaB, and RaC were determined for a human subject using the Colorado State University counter. Standard chair human geometry was calibrated for ^{226}Ra. The rate of release of the major nutritional cations from feed, Na^+, K^+, Ca^{++}, and Mg^{++} was determined in water solution. The studies were carried out by placing alfalfa samples in a container with water and sampling the solution every five min over a 90 min interval. There was a rapid burst of these ions from feed over the first five min of water extraction followed by a somewhat slower release over the next 90 min. Effects of K on cation balance and metabolic rate in rats were determined. The effects of rubidium on K metabolism in chicks were studied. Experiments on the availability of radiocesium from alfalfa hay showed that ^{134}Cs in plants was readily solubilized by treatment with acid detergent fiber solvent, while fallout ^{137}Cs was related to the degree of solubility. The relationship of K to body composition was determined in cattle, hogs, rabbits, rats, and sheep. These determinations are necessary for the use of whole-body counters. Computer programs, after accepting information on choice of crystal, energy ranges, counting geometry, and other factors, sum the counts in appropriate energy regions, allow for Compton contributions, apply the calibration factor, and compute a result that is then presented in tabular form. A list of 34 publications and manuscripts prepared during the year is included. (H.L.W.)

21461 EFFECTS OF ^{40}K ON MEASUREMENT OF SPECIMENS IN THE BIOSPHERE. Zaduban, Milan; Medvidova, Lydia (Kosice Univ., Czech.). Jad. Energ., 14: 27-31(1968). (In Czech).

Measurements of specimens in the biosphere are affected significantly by activity of ^{40}K. An attempt was made to adjust the pulse reading rate in relation to the amount of potassium. The ratio obtained made it possible to measure specimens in the presence of potassium. (R.V.J.)

21462 VEGETATION AND FLORISTIC CHANGES ON A PORTION OF WHITE OAK LAKE BED. De Selm, H. R.; Shanks, R. E. (Univ. of Tennessee, Knoxville). Ecology, 48: 419-25(Late Spring 1967).

White Oak Lake of the Oak Ridge National Lab. was created in 1943 by damming White Oak Creek to produce a settling and dilution basin for radioactive (fission product) and chemical wastes. The lake was drained in the winter of 1955-56 and the exposed land surface was invaded rapidly by vegetation. Vegetational changes during the first five yr of succession on the White Oak Lake bed were followed as part of a study of the cycling of elements and radionuclides in the vegetation. From 1956 to 1960 the vegetation on three acres of the dry lake bed was identified, mapped, and clip-sampled. The plant collections revealed rapid influx of many species. Cover was almost complete the second year. The initial forb cover, made up chiefly of Polygonum, subsequently declined from 73% to 20%. Juncus and Carex, which provided the major cover in 1957 and 1959 respectively, had declined by 1960. Thickets and open woody stands of Salix developed in the first two years after the lake was drained. Only a slight correlation was found between the vegetation patterns and the isopleths of known physical or chemical soil characteristics. (BBB)

21463 ROLE OF ARTHROPODS AND MICROFLORA IN BREAKDOWN OF WHITE OAK LITTER. Witkamp, Martin; Crossley, D. A. Jr. (Oak Ridge National Lab., Tenn.). Pedobiologia, 6: 293-303(1966).

The effects of soil arthropods on leaf litter breakdown were estimated in field experiments utilizing naphthalene to reduce or exclude arthropod populations. Weight loss and radioactive cesium loss by decaying oak leaf litter were measured with litterbag and gravimetric methods. Periodic applications of 100 g of naphthalene per m^2 reduced arthropod populations to 20% of controls, increased bacterial populations on the leaves up to six fold, and tended to reduce microbial populations of the sub-soil, but generally did not affect CO_2 evolution from litter plus soil. Litter in treated plots retained about 55% of its weight after one year, compared to 40% in control plots. Radiocesium loss rates also were reduced in treated plots. These results are consistent with the hypothesis that the gross effects of soil arthropods include fragmentation of leaf litter, thus exposing a greater surface area to microbial attack and leaching. (auth)

21464 ADAPTATION OF ANIMALS TO ELEVATED NATURAL BACKGROUND RADIATION. Raushenbakh, Yu. O.; Monastyrskii, O. O. pp 165-76 of Vliyanie Ioniziruyushchikh Izluchenii na Nasledstvennost'. Dubinin, N. P. (ed.). Moscow, Izdatel'stvo Nauka, 1966. (In Russian).

The animals investigated (Citellus undulatus Pall., Microtus gregalis Pall., Allactaga saltator Eversm., Allolobophora magnifica, and Eisenia nordenskiöldi) were collected in four regions with an elevated level of natural background radiation and four regions with a normal radiation level. Their reactions were studied after they received x ray doses of 170 to 282 R per month for four months, and after a two-month interruption, doses of 300 R per month for six months, or after they received a single dose of 100 R. The animals from the region with the higher radiation level had a higher survival rate and a lower percentage of chromosome aberrations; their muscles had a lower oxidation-reduction potential, and they displayed less sensitivity to a source of x radiation. (JPRS)

Genetics and Cytogenetics

Refer also to abstracts 21464, 21554, 21555, 21577, 21594, 21628, 21629, 21631, 21633, and 21643.

21465 (RLO-353-22) DEVELOPMENT OF GENETIC METHODS FOR WHEAT IMPROVEMENT. Progress Report. Konzak, C. F.; Ramirez-A, I.; Woo, S. C. (Washington State Univ., Pullman. Coll. of Agriculture). Aug. 1967. Contract AT(45-1)-353. 14p. (CONF-670942-2). Dep. CFSTI.

From FAO/IAEA Panel on Induced Mutations in Plant Breeding, Meeting, Vienna, Austria.

Studies were conducted on the frequency and types of stripe rust (Puccinia striiformis) resistant mutants induced by chemicals and radiation in the Marfed variety of wheat. Semi-dwarf mutants, induced by EMS, were found to have lower yields than control plants. Genetic analyses of these plants were made. Experiments were conducted on the relation between plant height expression and the amount of heterosis for several characters related to grain yield increase. Studies were continued on inheritance of other induced agronomic improvements such as increased tillering, improved milling quality, upright growth, and potentially useful genetic markers. The effects of EMS on restorer factors in cytosterile wheat were investigated. The efficiency and effectiveness of mutagens were investigated using yeast and barley. The effects of a series of alkyl alkane sulfonates were determined. Experiments with methyl isopropanesulfonate indicated that it was more mutagenic than other methylating sulfonates tested. The effects of temperature and time on induction of mutations in barley by EMS were determined. Studies on the effects of ethylenimine on barley showed that damage to the biological system increased with increasing pH, and that the effect of the mutagen was increased markedly if the seeds were dried back after treatment. Experiments on the influence of pretreatment leaching on mutagenic effects were conducted. (H.L.W.)

21466 MEIOTIC CONSEQUENCES OF A COMBINED TREATMENT FAST NEURONS-FUDR IN VICIA FABA. Moutschen-Dahmen, M.; Moutschen, J. (Univ., Liege). Experientia, 23: 582-3(July 15, 1967).

Seeds of Vicia faba were irradiated with fast neutrons. One lot was treated with FUDR and these seeds were planted. The buds of the flowers were then fixed. It was observed that the lot treated with FUDR after irradiation showed a higher frequency of chromosome aberrations in meiosis. The proportion of different types of aberrations was determined and results are tabulated. The modification of the effects of fast neutrons by FUDR was demonstrated by the results. (H.L.W.)

21467 THE DNA SYNTHESIS AND THE DIFFERENTIAL SENSITIVITY TO UV-RADIATION OF DIFFERENT CHROMOSOME 1 REGIONS IN CULTURED CHINESE HAMSTER CELLS. Antoshechkin, A. G.; Tolkacheva, E. N. (Inst. of Atomic Energy, Moscow). Genetika, No. 11, 166-8(Oct. 1967). (In Russian).

The distribution of breaks induced by uv radiation was compared to the distribution of silver grains along chromosome 1 in ^{3}H-thymidine labeled metaphases of Chinese hamster cells in vitro. As shown by autoradiographic studies, the frequency of breaks occurring during the early S-phase was highest in those chromosome regions, in which the DNA synthesis is the most intense at the time of uv-irradiation. A higher breakage frequency in the same region can be induced at the early S-stage by aminopterin, an inhibitor of the DNA synthesis. (auth)

21468 MODERN TRENDS OF MAMMALIAN RADIATION GENETICS. Shapiro, N. I.; Pomerantseva, M. D. (Inst. of Atomic Energy, Moscow. Inst. of General Genetics, Moscow). Genetika, No. 11, 120-44(Oct. 1967). (In Russian).

The effects of different types of ionizing radiation on the germinal cell genome of mice and other mammals under different conditions of irradiation are considered. On the basis of the experimental data a tentative method of estimating genetic risk of radiation damage for humans is proposed. The effect of radiation on somatic cell genome is also considered in connection with two problems: the role of nuclear injuries in the radiation death of mammals, and the late consequences of radiation effects (tumor development and premature aging). In conclusion the problems of chemical protection of cell genome against deleterious effects of radiation and the post-radiation repair of hereditary material are discussed. (auth)

21469 MICROBIOLOGICAL ASSAY OF METHIONINE BY MEANS OF A MUTANT OF E. COLI K_{12}. Chen, Chung-fu (Futan Univ., China). Wei Sheng Wu Hsueh Pao, 8: 455-8 (Dec. 1962). (In Chinese).

A methionine-requiring mutant M-1-10 was obtained from E. coli K12 through ultraviolet irradiation followed by penicillin treatment. The merit of this mutant in microbiological assay was its genetic stability and high specificity in nutrient requirement, especially shown by its lack of reaction towards vitamin B_{12}. The range for methionine assay is 1 to 40 micrograms/5 ml in turbidimetrical method, and 20 to 80 micrograms/ml in agar diffusion method, the error of quantitative determination being all within the range of 5%. (auth)

21470 OBTAINING VITAMIN B_1-DEFICIENT VARIETIES OF CANDIDA UTILIS THROUGH γ RADIATION AND COMPARISON OF THEIR BIOLOGICAL PROPERTIES WITH THE ORIGINAL STRAIN. Chuang, Tseng-hui; Chien, Chia-sun. Wei Sheng Wu Hsueh Pao, 8: 437-45(Dec. 1962). (In Chinese).

It was determined that the cell survival rate in Candida utilis drops with an increase of the radiation dosage. Their survival rate is of an exponential nature in relation to the dosage. The half-lethal dose for C. utilis is 52,000 R. Of the 2012 nutritionally deficient variants obtained by us, 31 vitamin B_1-deficient variants were selected. These constitute 1.54% of all nutritionally deficient variants. In comparison with the initial strain, cell dimensions, diameter of colonies, rate of oxygen absorption and degree of pseudo-mycelium development of vitamin B_1-deficient Candida variants turn out to be different to a smaller or greater degree. Moreover, the logarithmic growth phase of the latter is lengthened. Data on the cytochrome system in all vitamin B_1-deficient variants showed that cytochrome-a is absent in only five vitamin B_1-deficient variants. The vitamin B_1-deficiency of the obtained variants that were subjected to subculture transfer 20 to 50 times on sulo-agar, were unchanged during a period of more than two years. (auth)

21471 RELATION BETWEEN THE CYTOGENETIC EFFECT OF GAMMA-RAYS AND THE STAGE OF DEVELOPMENT OF THE IRRADIATED OBJECT. Safin, M. K.; Demchenko, V. E.; Musaelyan, M. S. (Inst. of Botany, Kiev). Ukr. Bot. Zh., 23: No. 5, 23-7(1966). (In Russian).

On irradiation of rye seeds with γ rays the incidence of cells with chromosome aberrations was the same for sprouts of diploid and tetraploid rye. In the experiments conducted in this instance, sprouts of diploid and tetraploid rye were irradiated with γ rays in doses of 100–1,500 rad. The incidence of cells with chromosome rearrangements counted in the anaphases and telophases was almost twice as high in tetraploid vs diploid rye on irradiation of the sprouts with 100 rad. This difference decreased with increasing doses of radiation and disappeared almost entirely at 1,500 rad. The relation found differed from that observed on irradiation of seed, in which a protective effect associated with the dormant condition is exerted. The number of chromosome aberrations per cell and the ratio of aberrations of different types in a cell were the same on irradiation of diploid as of tetraploid rye sprouts. The unchanged number of aberrations per cell at double the number of chromosomes for tetraploid rye indicated that chromosomes of tetraploid rye had a greater resistance to the effects of radiation than those of diploid rye. (auth)

21472 CHROMOSOMAL CHANGES INDUCED BY X-RAY THERAPY. Gripenberg, Ulla (Univ. of Lund, Sweden). Hereditas, 57: 439-41(1967).

Leukocytes were cultured from ten cancer patients who received post-operative x-ray therapy. Controls consisted of leukocytes taken from cancer patients immediately after operation before radiation treatment was started. Cells from irradiated patients showed a greater variation in the frequency of aneuploid cells. Aberrant cells including di- and polycentric chromosomes, markers, and fragments were observed and analyzed. Polyploid cells were seen in high frequency in four of the ten patients. (H.L.W.)

21473 VLIYANIE IONIZIRUYUSHCHIKH IZLUCHENII NA NASLEDSTVENNOST'. (Effect of Ionizing Radiation on Heredity). Dubinin, N. P. (ed.). Moscow, Izdatel'stvo Nauka, 1966. 320p.

Separate abstracts were prepared on thirty-five chapters that discuss the effects of ionizing radiations on heredity in microorganisms, plants, and cultured animal cells. Two other chapters discuss the effects of chemical mutagens. (C.H.)

For abstracts of individual chapters see: 21432, 21433, 21464, 21474–21495, 21554, 21555, 21607–21611, and 21631–21633.

21474 ANALYSIS OF THE NATURE OF RADIATION DAMAGE TO CHLORELLA CELLS. Shevchenko, V. A. pp 8-15 of Vliyanie Ioniziruyushchikh Izluchenii na Nasledstvennost'. Dubinin, N. P. (ed.). Moscow, Izdatel'stvo Nauka, 1966. (In Russian).

An analysis of the cause of damage to Chlorella cells induced by x radiation showed cytoplasmatic death of the cells and death due to lesion of the genetic structures. Cell death in a wide range of doses was caused exclusively by genetic damage. Death without preliminary growth at the young cell stage was manifested only at a dose of 40 kR, when the survival rate of the culture did not exceed 1 to 2%. In this case most cells that died as a consequence of cytoplasmic damage had lethal mutations. At doses up to 20 kR the cells mainly died as a result of lethal point mutations which produced, after a phenotypic lag, a characteristic picture of symmetric death. The duration f the phenotypic lag depended on the age of the cell at the moment of occurrence of the lethal mutation, on the nature of the mutation itself, and on the degree of radiation damage to the cytoplasm. The number of inactivated large and giant cells increased in proportion to some power of the dose greater than one, which made it possible to relate the appearance of these cells with the occurrence of large chromosomal aberrations in them. (ATD)

21475 POSSIBILITY OF REPAIR OF GENETIC DAMAGES INDUCED BY IONIZING RADIATIONS IN TORULOPSIS UTILIS. Sokurova, E. N.; Volkova, T. M. pp 22-7 of Vliyanie Ioniziruyushchikh Izluchenii na Nasledstvennost'. Dubinin, N. P. (ed.). Moscow, Izdatel'stvo Nauka, 1966. (In Russian).

A study was made of the dependence of the frequency of biochemical mutations in the yeast Torulopsis utilis on the duration of their incubation in water after x- and γ irradiation at dose rates, respectively, of 2380 R/min and 384 R/min. Incubation of the yeast cells in water lasted 4 to 5 days. The results of the experiments showed that when the yeast cells were irradiated and then incubated in water there was a substantial increase in their survival rate. Post-irradiation recovery was observed on the first two days of incubation, the survival rate did not increase with further incubation, and the curves formed a plateau indicating the presence of an irreversible component. The slight increase in the percentage of mutant cells in the reacting population was ascribed to the following causes: in mutant cells recovery from damages causing their inactivation occurred more readily; mutant cells were freed from some of the genetic damages usually masking biochemical mutations, as a result of which the total number of mutants recorded in the experiments increased; since the increase in the percentage of mutant cells in the reacting population mainly occurred as a result of mutants with a slow growth, it was not precluded that this group partially included cells with a temporary growth delay as a result of irradiation. The choice between these possibilities requires further investigations. (ATD)

21476 MUTAGENIC AFTEREFFECT OF THE RADIOMIMETIC COMPOUND THIO-TEPA ON THE NUCLEI OF HUMAN CELLS IN TISSUE CULTURE. Dubinin, N. P.; Vaulin, E. P.; Saprykina, E. G. pp 46-61 of Vliyanie Ioniziruyushchikh Izluchenii na Nasledstvennost'. Dubinin, N. P. (ed.). Moscow, Izdatel'stvo Nauka, 1966. (In Russian).

An investigation of the results of one treatment of cultured human embryo cells with the radiomimetic compound thio-TEPA, showed that it has a latent, mutagenic effect. The effect was seen in new chromosome mutations arising in the second and third cell generations after exposure to the mutagen in the first generation. The character of the mutagenic effect was expressed by an increase in the number of chromosome mutations in the second generation and, apparently, by a decrease in the third. At the first stage of the mutagenic effect, in the second generation, there was an increase in the number of mutations as a consequence of the development of some initial damage of the chromosomes or cytoplasmic substances. At the second stage of the third generation, there was a decrease in the number of reaction products. This led to the conclusion that the general picture of latent mutagenic effect is related to a chain-reaction process in mutagenesis. (ATD)

21477 EFFECT OF RADIATION ON THE MITOTIC CYCLE OF CELLS. THE RADIOSENSITIVITY OF FIBROBLASTS OF EMBRYONIC TISSUES OF MICE IN DIFFERENT PHASES OF THE CYCLE. Mitrofanov, Yu. A.; Tarasova, T. S. (Inst. of Biophysics, Moscow). pp 69-78 of Vliyanie Ioniziruyushchikh Izluchenii na Nasledstvennost'. Dubinin, N. P. (ed.). Moscow, Izdatel'stvo Nauka, 1966. (In Russian).

Cells of a culture of fibroblasts from 13 to 15-day embryos of mice were incubated at 37°C. After they reached a logarithmic stage of growth, they were x irradiated for two minutes at 15 mA and 210 kV with 0.5 mm Cu and Al filters at 17 to 19°, then incubated and fixed after periods varying from 2 to 70 hours. The percentage of cells with chromosome aberrations and the types of aberrations were determined (chromatid and chromosome bridges with and without fragments, single and paired fragments and rings). The cell population of the first culture of fibroblasts were heterogeneous in ploidy and in length of the mitotic cycle, which was 22 hours, with considerable fluctuations, and was little affected by a dose of 35 R. Most aberrations arose among cells irradiated in the middle G_2 phase, then in the S and lastly in the G_1. The radiosensitivity varied widely in a single phase. (JPRS)

21478 RELATIVE GENETIC EFFECTIVENESS OF VARIOUS TYPES OF IONIZING RADIATIONS IN MAMMALS. Arsen'eva, M. A.; Golovkina, A. V.; Belyaeva, L. A. pp 115-21 of Vliyanie Ioniziruyushchikh Izluchenii na Nasledstvennost'. Dubinin, N. P. (ed.). Moscow, Izdatel'stvo Nauka, 1966. (In Russian).

The relative genetic effectiveness of various types of radiation (fast neutrons, x, γ, and protons) was determined by the frequency of nuclear disturbances in the cells of various mouse tissues. Chromosomal aberrations in the germ epithelium of the testes at stage 1 of spermatogenesis and in bone marrow cells were recorded. It was established that the effect of fast neutrons with an energy of 1 to 2 MeV had the highest effectiveness in comparison with x and γ rays. The relative genetic effectiveness of fast neutrons was about 3 to 4. Protons with an energy of 120 to 660 MeV demonstrated a smaller effectiveness in comparison with γ and x rays. The relative genetic effectiveness of the protons was 0.6 to 0.8. (ATD)

21479 COMPARATIVE ANALYSIS OF THE MUTAGENIC EFFECT OF AN ALKYLATING COMPOUND (THIO-TEPA) AND RADIATION ON MOUSE BONE MARROW CELLS. Arsen'eva, M. A.; Golovkina, A. V. pp 122-30 of Vliyanie Ioniziruyushchikh Izluchenii na Nasledstvennost'. Dubinin, N. P. (ed.). Moscow, Izdatel'stvo Nauka, 1966. (In Russian).

A comparative analysis of the effect of x radiation in a dose of 100 R and the intraperitoneal injection of ethylenimine (Thio-TEPA) in a dose of 4 mg/kg showed certain differences in the effect of these two mutagens when the bone marrow cells of mice were studied. Ethylenimine in the indicated dose caused an appreciably more pronounced cytotoxic and cytostatic effect than the radiation. The mutagenic effect of ethylenimine showed up at appreciably later periods after injection in comparison with the effect of radiation and it was found to be related with the appearance of both chromatid and chromosome aberrations. (ATD)

21480 FREQUENCY OF CHROMOSOMAL ABERRATIONS IN MOUSE GERM CELLS FOLLOWING SINGLE AND FRACTIONATED IRRADIATION. Bochkov, N. P. pp 131-4 of Vliyanie Ioniziruyushchikh Izluchenii na Nasledstvennost'. Dubinin, N. P. (ed.). Moscow, Izdatel'stvo Nauka, 1966. (In Russian).

The frequency of chromosomal aberrations in the anaphases of the first and second meiotic division in mouse testes was studied under conditions of single and fractionated doses of x radiation. The animals were whole-body irradiated in a dose of 150 R at a rate of 15 R/min for 10 min. Fractionated irradiation was carried out for seven days, at a daily dose of 21.5 R. The single-irradiated mice were killed after 50, 123, and 190 hr, which corresponded to the time of meiosis from the stage of early, middle, and late pachynema, respectively, to the anaphase of the first and second divisions. It was found that with single irradiation of mice at various stages of the pachynema there was an average of 0.058% cells with chromosome damages per 1 R. The fractionated doses did not substantially change the number of chromosomal aberrations: 0.064% cells with damages occurred per 1 R. In the anaphases of the second division the number of radiation-induced aberrations was $\frac{1}{3}$ of that in the anaphases of the first division. (ATD)

21481 EFFECT OF IONIZING RADIATION ON DNA SYNTHESIS AND MITOTIC CYCLE OF CELLS OF HEMATOPOIETIC TISSUE. Zosimovskaya, A. I. pp 135-45 of Vliyanie Ioniziruyushchikh Izluchenii na Nasledstvennost'. Dubinin, N. P. (ed.). Moscow, Izdatel'stvo Nauka, 1966. (In Russian).

The effect of ^{60}Co γ rays in a dose of 400 R on DNA synthesis and the mitotic cycle of cells in two highly radiosensitive mouse tissues was studied, using bone marrow and lymphocytes of lymph nodes. The average duration of the mitotic cycle of large and medium lymphocytes of the inguinal lymph nodes was 23 to 25 hr at a duration of the DNA synthesis period equal to 7 hr, which amounted to 30.4% of the total time of the cycle. For the erythroid and myeloid cells of the bone marrow the average time of the mitotic cycle was 13.3 to 14.5 and 20.8 to 21.5 hr. The time of the DNA synthesis period was 3.5 to 5.3 and 6 to 7 hr, which amounted respectively to 37 and 33.6% of the cycle time. In all tissues investigated irradiation caused identical disturbances in the passage of the cells through the periods of the mitotic cycle: the occurrence of blocking of G_2-M and G_1-S and a disturbance of DNA synthesis (blocking S-G_2). During postirradiation recovery the G_2-M block was first removed, then the S-G_2 block, and last to be removed was the G_1-S block. The duration of the blocks and the disturbance of DNA synthesis were approximately the same in all tissues, but the G_1-S block and the degree of disturbance of DNA synthesis in the lymphoid and erythroid tissues were evidenced more strongly than in the myeloid tissue. Cells which were in the DNA synthesis period and postsynthetic period, G_2, at the time of irradiation were more sensitive to its effect than the cells irradiated in the presynthetic period, G_1. The investigation showed that with γ irradiation similar disturbances, which are a characteristic reaction of most tissues to irradiation, occur in the mitotic cycle of the tissues studied, which were distinguished by a high radiosensitivity. (ATD)

21482 CHROMOSOME ABERRATIONS IN THE BONE MARROW CELLS OF MONKEYS LONG AFTER IRRADIATION. Movchan, O. T.; Avdzhian, M. V.; Grigorenko, T. E. (Inst. of Experimental Pathology and Therapy, Sukhumi, USSR). pp 146-50 of Vliyanie Ioniziruyushchikh Izluchenii na Nasledstvennost'. Dubinin, N. P. (ed.). Moscow, Izdatel'stvo Nauka, 1966. (In Russian).

Male and female monkeys (Macaca mulatta) were totally x-irradiated at ages of 1.5 to 8 years with doses varying from 160 to 721 R and their bone marrow was investigated at different times from 11 months to 8 years, 8 months later. Chromosome aberrations were analyzed and counted in the anaphase and telophase, and were 2 to 3 times as frequent as in controls. The presence of chromosome bridges indicated damage to some marrow cells in the pre-synthetic phase of the cell cycle. Disturbance of mitosis (adhesion of chromosomes) was found in the irradiated, but not in the unirradiated, monkeys. (JPRS)

21483 MOSAICISM OF INHERITANCE OF SEX-LINKED RECESSIVE LETHALS OF DROSOPHILA MELANOGASTER IN CONNECTION WITH CHROMOSOME STRUCTURE. Glembotskii, Ya. L.; Abeleva, E. A.; Grozdova, T. Ya.; Myasnyankina, E. N. pp 188-200 of Vliyanie Ioniziruyushchikh Izluchenii na Nasledstvennost'. Dubinin, N. P. (ed.). Moscow, Izdatel'stvo Nauka, 1966. (In Russian).

The purpose of this investigation was to elucidate the mechanism for the development of gonadal mosaicism, and hence solve the problem of the chromosome structure in gametes at postmeiotic stages of their development from one or two threads, and to clarify the problem of the relative frequency of the occurrence of chromatid sex-linked recessive mutations in comparison with the frequency of such chromosome mutations. It was shown that chromatid, along with chromosomal, sex-linked recessive lethals occurred following irradiation of the male gametes of Drosophila at postmeiotic stages. During γ irradiation in a dose of 1000 R they amounted to 21% of the number of chromosome mutations, and during irradiation by 1-MeV fast neutrons in a dose of 1000 rad + 250 R of γ rays, they amounted to 13% of the number of chromosome mutations. The question of the time of formation of chromatid point mutations, whether directly in the irradiated gametes or in the zygote as a result of the secondary effect of irradiation, was left unsolved. (ATD) (TS8)

21484 COMPARATIVE STUDY OF CROSSING-OVER IN TWO LINES OF DROSOPHILA MELANOGASTER. Sinkha, Suresh P. (Leningrad State Univ.). pp 201-8 of Vliyanie Ioniziruyushchikh Izluchenii na Nasledstvennost'. Dubinin, N. P. (ed.). Moscow, Izdatel'stvo Nauka, 1966. (In Russian).

Heterozygotic females of two lines of Drosophila melanogaster, Magarach and D-18, 0 to 24 hrs old were kept at 37° for eight hours. A high rate of crossing-over was found in the offspring on the sixth to seventh day. After irradiation with 2000 R of x rays, flies exhibited the same increase on the sixth to seventh days and it was also found to the 11th day in Magarach and the 14th day in D-18. Comparative study of the induced crossing-over showed the former is radioresistant and the latter radiosensitive. After irradiation with 2000 R it was found that higher temperatures increased the frequency of induced crossing-over in Magarach but not in D-18, and that the increase occurred in D-18 with a dose of 1000 R. (JPRS)

21485 NORMALIZING EFFECT OF ARGININE ON THE CHARACTER OF THE DEPENDENCE OF THE FREQUENCY OF MUTATIONS IN DROSOPHILA SPERMATIDS ON THE DOSE OF IONIZING RADIATION. Abeleva, E. A. pp 209-19 of Vliyanie Ioniziruyushchikh Izluchenii na Nasledstvennost'. Dubinin, N. P. (ed.). Moscow, Izdatel'stvo Nauka, 1966. (In Russian).

Results are reported from studies on γ-irradiated Drosophila that demonstrated that the curve of the dose dependence of the frequency of occurrence of sex-linked recessive lethals in fruitfly spermatids (5th day postirradiation) is bell-shaped. The average fertility of the males at a dose of 3000 R was very low (1.0 offspring per day). The frequency of mutation during spermiogenesis at a dose of 3000 R (on the 4 to 7th day postirradiation) was maximum in late spermatids (4th day) and markedly less at earlier stages. The fertility of males at this time also dropped, reaching 0.3 offspring per male on the 7th day. For the males that received arginine during larval development, the maximum frequency of mutations was observed on the 5th day, then it also dropped, but not so markedly. The percentage of mutations in the 5 to 7th matings of the males that received arginine was higher than for those that did not receive it, their fertility at this time also being about double. The increase in the frequency of mutations of males that received arginine in matings with a severely lowered fertility was explained by the survival of the highly radiosensitive gametes under the effect of arginine. The dose-dependence of the frequency of mutations in spermatids became normalized, approaching linear, under the effect of arginine. Possible mechanisms of the effect of arginine on radiation mutagenesis and the nature of premutation changes arising in the chromosomes are discussed. (ATD)

21486 EXPERIMENTAL STUDY OF THE RADIOSENSITIVITY OF VARIOUS MITOTIC PHASES IN CREPIS CAPILLARIS. Sidorov, B. N.; Sokolov, N. N. pp 220-30 of Vliyanie Ioniziruyushchikh Izluchenii na Nasledstvennost'. Dubinin, N. P. (ed.). Moscow, Izdatel'stvo Nauka, 1966. (In Russian).

The sensitivity of various mitotic phases in Crepis capillaris to x radiation was studied. The criterion of sensitivity was the frequency of asymmetric chromosomal aberrations in colchicine-treated metaphases. The analysis was made for the first two mitoses after irradiation, i.e., in diploid and tetraploid cells. The sensitivity of certain stages not easily accessible to analysis was determined. The results showed high sensitivity to irradiation of the anaphase, metaphase, and late prophase, and a gradual decrease of sensitivity in the early propase, G_2, and especially during G_1. Analysis of aberrations in the second K-mitosis made it possible to compare the data with respect to chromatid deletions obtained in the first K-mitosis, and this analysis showed that the so-called gaps do not lead to any inherited changes in the chromosomes. The presence in C. capillaris of three pairs of identifiable chromosomes (A, C, and D) made it possible to reveal certain deviations from the random distribution of chromosome breaks in aberrations of the one- and two-hit type. (ATD)

21487 SIGNIFICANCE OF THE PROCESS OF COMBINATION AND RECOMBINATION OF BREAKS CAUSED BY X RAYS RELATIVE TO THE RADIOSENSITIVITY OF CHROMOSOMES. Sidorov, B. N.; Sokolov, N. N. pp 231-8 of Vliyanie Ioniziruyushchikh Izluchenii na Nasledstvennost'. Dubinin, N. P. (ed.). Moscow, Izdatel'stvo Nauka, 1966. (In Russian).

A study was made of the change in the frequency of x-ray-induced sister combinations of chromosome breaks during the mitotic cycle in rootlets of Crepis capillaris. It was shown that there was a gradual drop in the frequency of combinations from the late prophase toward the early G_2 and a marked drop upon changing to G_1. An additional peak of a high frequency of unions was noted immediately after the end of stage S, which was explained by the closeness of the ends of the broken chromatids. Simultaneously with the drop in the frequency of sister unions in isochromatid deletions there was an increase in the ratio of the frequencies of isochromatid and chromatid deletions. It was concluded that there is a simultaneous change in the capacity of the broken ends of the chromosomes both for combining and recombining which leads to a restoration of the original structure of the chromatid and thus to a change in isochromatid deletions to chromatid deletions. The data indicate the importance of secondary, modifying factors in determining the ultimate yield of chromosomal aberrations. (ATD)

21488 COMPARATIVE ANALYSIS OF THE CYTOGENETIC EFFECTS OF X RAYS, HIGH-ENERGY PROTONS, AND FAST NEUTRONS ON CHROMOSOMES OF CREPIS CAPILLARIS. Shevchenko, V. V. pp 239-52 of Vliyanie Ioniziruyushchikh Izluchenii na Nasledstvennost'. Dubinin, N. P. (ed.). Moscow, Izdatel'stvo Nauka, 1966. (In Russian).

A comparison of the cytogenetic effect of x rays (maximum 190 kV), protons (120 MeV), and fast neutrons (1.5 MeV) was carried out using the chromosomes of irradiated Crepis capillaris sprouts. The metaphase method of analyzing chromosome aberrations was used and the localization of breaks over the length of the chromosome arms was determined. It was established that the meristematic cells of the root tip of C. capillaris have a maximum sensitivity to all the investigated types of radiation when irradiated in the G_2 stage, the sensitivity gradually dropping upon changing from G_2 to S and S_1. The RBE of neutrons with respect to x rays was about 15, and for neutrons was about 1. For all three types of radiation the author observed a very close agreement in the percentage of breaks in the chromosome arm, and in two different types of aberrations these values were different: if in the isochromatid deletions the long arm of the chromosome experienced maximum breaks, then in the chromatic translocations the maximum shifted to the shorter arm of the D-chromosomes. Localization of the breaks over the length of the chromosome arms was similar for all three types of radiation: for the isochromatid deletions the maximum frequency of breaks was observed in the middle of the arms and the minimum frequency on the proximal and distal ends; for the chromatid translocations the maximum frequency of breaks shifted toward the distal ends of the chromosomes. An analysis of the types of aberrations showed elements of similarity and differences in the qualitative effect of the investigated radiations. The similarity of protons and neutrons and their difference from x rays is explained by the presence of a densely ionizing component in proton and neutron irradiation and its absence in x-irradiation. However, with respect to some criteria neutrons were closer to x rays than to protons. (ATD)

21489 EFFECT OF THE PHYSIOLOGICAL CHARACTERISTICS OF POLYPLOID SEEDS ON FREQUENCY OF RADIATION-INDUCED CHROMOSOMAL ABERRATIONS. Sakharov, V. V.; Mansurova, V. V.; Platonova, R. N. pp 258-68 of Vliyanie Ioniziruyushchikh Izluchenii na Nasledstvennost'. Dubinin, N. P. (ed.). Moscow, Izdatel'stvo Nauka, 1966. (In Russian).

The effects of γ rays and fast neutrons on the seeds of the diploid form (2x = 12) and autotetraploid form (4x = 24) of Nigella damascena are described. The irradiated seeds of both forms were investigated either immediately or after storing them for from 3 to 12 months after irradiation. After the seeds germinated the anaphases of the first mitoses were investigated in the rootlets. When the seeds were germinated immediately after γ irradiation it was found that the chromosomes of the 4x form were almost twice as radioresistant as the chromosomes of the 2x form. However, the autotetraploid form proved to be unprotected against the effect of fast neutrons. Equal percentages of chromosome aberrations occurred in the 2x and 4x forms only when the diploids received a dose of fast neutrons that was twice that received by autotetraploids. An investigation of the seeds irradiated with γ rays and stored for various periods revealed that there was a sharp increase in both forms of the percentage of chromosomal aberrations up to 6-month storage with a subsequent gradual return to the initial percentage of aberrations noted immediately after irradiation of the seeds. A study of the ratio of chromatid and chromosome bridges elicited a pronounced predominance of the former (70% for the 2x and 75% for the 4x). Diploid and autotetraploid forms of Nigella damascena proved to be good material for a biochemical investigation of the radioresistance of plants. (ATD)

21490 COMPARATIVE STUDY OF EFFECT OF CERTAIN CHEMICAL AND PHYSICAL MUTAGENIC FACTORS ON BARLEY SEEDS. Khalil, A. A.; Khvostova, V. V.; Stoletov, V. N. pp 269-76 of Vliyanie Ioniziruyushchikh Izluchenii na Nasledstvennost'. Dubinin, N. P. (ed.). Moscow, Izdatel'stvo Nauka, 1966. (In Russian).

An attempt was made to determine the specificity of action of

certain physical and chemical mutagens on seeds of barley. Among the mutagenic factors investigated, fast neutrons in a dose of 600 rad and ethylmethane sulfonate in a concentration of 0.5% were found to reduce the germination rate most, inhibit plant growth, and adversely affect the grain content, density of the spike, and number of grains in the spike. On the basis of studies of chlorophyll mutations, it was concluded that fast neutrons were more effective than γ rays, but for barley, produced a similar spectrum of chlorophyll mutations, mainly the Albina type (68.6%). Of the chemical mutagens the most effective with respect to number of mutations was ethylmethane sulfonate but ethylenimine yielded the greatest diversity of chlorophyll mutations. When the growing plants were exposed to chronic γ irradiation the number of mutations was greater by a factor of 23 than when dormant seeds were exposed. (ATD)

21491 MUTABILITY OF THE BROAD BEAN VICIA FABA UNDER THE EFFECT OF GAMMA RAYS AND CHEMICAL AGENTS. Dishler, V. Ya.; Khvostova, V. V.; Valeva, S. A.; Turkov, V. D. pp 277-86 of Vliyanie Ioniziruyushchikh Izluchenii na Nasledstvennost'. Dubinin, N. P. (ed.). Moscow, Izdatel'stvo Nauka, 1966. (In Russian).

Small doses (500 to 1000 R) of γ rays or low concentrations (0.01%) of ethylenimine proved to be the most effective of the mutagens investigated for producing the greatest number of hereditary changes in the broad bean Vicia faba minor. These agents increased the variability of this plant by 2 to 2.8 times. Altered morphological characters pertaining to all parts of the plant, bush, leaves, flowers, beans, and seeds, were obtained under the effect of the mutagens. Of economic value were the characteristics produced by polygene factors. The results of the experiment led to the conclusion that the selection of plants with respect to such characters is possible. The nature of the occurrence of leaf spottiness in M_1 plants and the question as to what portion of the M_1 plants contains the mutation after treating the dormant seeds are discussed. (ATD)

21492 COMPARISON OF EFFECTS OF γ RAYS, ETHYLENIMINE, AND ETHYLMETHANE SULFONATE ON PEAS. Enken, V. B.; Sidorova, K. K. (Inst. of Cytology and Genetics, Novosibirsk, USSR). pp 287-93 of Vliyanie Ioniziruyushchikh Izluchenii na Nasledstvennost'. Dubinin, N. P. (ed.). Moscow, Izdatel'stvo Nauka, 1966. (In Russian).

Air-dried peas of the Torsdag variety were irradiated with ^{60}Co γ rays at a dose of 5 kR before sowing; other seeds were soaked for 12 hours in aqueous solutions of ethylenimine (0.04%) or ethylmethane sulfonate (0.1%) and then washed for one hour in running water. Seeds thus treated produced 40 to 48 times as many mutants as the controls, with practically no difference in the number of mutants produced by the three methods. There was considerable difference in the frequency of individual types of mutants. (JPRS)

21493 VARIABILITY OF THE GLUTEN CONTENT AND THE BAKING PROPERTIES OF INTRASPECIFIC HYBRID SOFT WHEAT INDUCED BY γ AND X RAYS. Maistrenko, O. I.; Pal'chikova, G. M. (Inst. of Cytology and Genetics, Novosibirsk, USSR). pp 249-301 of Vliyanie Ioniziruyushchikh Izluchenii na Nasledstvennost'. Dubinin, N. P. (ed.). Moscow, Izdatel'stvo Nauka, 1966. (In Russian).

Hybrid seeds (Marquise-Strela, Extra-Prelude and Iskra, and Extra-Prelude and wheat-wheatgrass hybrid 22850) were irradiated with 5 kR, the first variety with γ rays and the second and third varieties with x rays, and sown three weeks later. In the three combinations the glucose content in M_2 had variations of 3.3, 8.9, and 19.3% of the coefficient of variation of the controls. The number of plants with a higher gluten content than the controls was 0.4 to 2.9% of all plants. No new forms that were promising from the aspect of gluten quality were found. (JPRS)

21494 DEPENDENCE OF MUTATION FREQUENCY ON TYPE AND DOSE OF THE MUTAGENIC FACTOR AND THE VARIETY PECULIARITIES OF SPRING WHEAT. Chernyi, I. V. (Inst. of Cytology and Genetics, Novosibirsk, USSR). pp 302-6 of Vliyanie Ioniziruyushchikh Izluchenii na Nasledstvennost'. Dubinin, N. P. (ed.). Moscow, Izdatel'stvo Nauka, 1966. (In Russian).

Air-dried seeds of Cesium 111 and Lutescence 758 spring wheat were irradiated with γ rays (1, 5, 10, and 15 kR) or fast neutrons (100, 250, 500, 750, and 1000 rads) or were soaked in 0.1% ethylenimine for 6, 12, 18, and 24 hours. Mutational changes were counted in the second generation. All the factors increased the mutational variability by 50 to 250 times. The frequency of mutations increased with the dose of γ rays and fast neutrons. Although γ rays and ethylenimine were highly effective, fast neutrons were even more effective in inducing mutations. Seeds of Lutescence 758 reacted much more strongly than those of Cesium 111. (JPRS)

21495 INFLUENCE OF THE PHYSIOLOGICAL STATE OF IRRADIATED SUNFLOWER SEEDS ON THE GENETIC EFFECT OF X RAYS. Beletskii, Yu. D.; Lyashchenko, I. F. (Rostov State Univ., USSR). pp 307-11 of Vliyanie Ioniziruyushchikh Izluchenii na Nasledstvennost'. Dubinin, N. P. (ed.). Moscow, Izdatel'stvo Nauka, 1966. (In Russian).

Seeds of the sunflower were x-irradiated in the air-dried state (4000 R) and wet (1000 R) at 60 R/min and germinated for several days at 20 to 22°C in Petri dishes. The mutagenic effect of the irradiation was quantitatively equal in the dry and wet seeds but the degree of fertility varied. The variability increased insignificantly, because of saturation of the populations with recessive mutations, and the range of inherited variability (chlorophyllous mutations) increased. The physiological state of the material modified both the qualitative and quantitative aspects of the genetic effects of the radiation. Valuable mutants were obtained, including early ripening, with a thick leaf cover and shortened internodes (with a higher frequency in the moistened seeds). (JPRS)

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Refer also to abstracts 21020, 21200, 21307, 21309, 21361, 21431, 21438, 21449, 21452, 21460, 21552, 21559, 21572, 21585, 21591, 21605, and 21643.

21496 (HASL-184, pp I,11-52) SIGNIFICANCE OF ^{137}Cs IN MAN AND HIS DIET. Gustafson, Philip F.; Miller, James E. (Division of Biology and Medicine (AEC), Washington, D. C.).

Cesium-137 from the worldwide fallout of nuclear test debris is ubiquitous in the biosphere, throughout the human diet, and is present in measurable quantity in the peoples of the world. Many measurements of ^{137}Cs were made in various media, including an AEC sponsored ^{137}Cs whole-body counting program for man and diet studies that were conducted by both AEC and PHS. Data on the content of ^{137}Cs in the diet and whole-body of man for the period 1961 through 1966 are presented. The human subjects examined may not represent the average population since they were drawn from a specific group, namely, laboratory and university personnel. The differences in ^{137}Cs whole-body burden across the country were less than anticipated on the basis of variations in regional ^{137}Cs fallout levels. This was attributed to a common source of such staple items as grain products and meats in the diet. The biological half life of ^{137}Cs in adults ranged from 50 to 150 days, and is sufficiently short so that equilibrium or near equilibrium between diet and body burden is established even during times when the dietary level of ^{137}Cs is changing fairly rapidly. The mean body burden of ^{137}Cs in the U. S. population is presented, and the radiation exposure due to this burden was calculated. Implications of the concentration effect observed in going from diet to man and the radiological importance of a possible long-term ^{137}Cs reservoir in bone are discussed. (C.H.)

21497 (HW-43112) BIOACCUMULATION OF RADIOELEMENTS FROM KAPL WASTE IN AQUATIC ORGANISMS. Pendleton, R. C. (General Electric Co., Richland, Wash. Hanford Atomic Products Operation). May 17, 1956. Contract AT(45-1)-1350. 14p. Dep. CFSTI.

Methods for determining bioaccumulation of radioisotopes from KAPL waste in aquatic organisms are described and results are tabulated. (H.L.W.)

21498 (ORNL-CD-4) INDEXES TO 563 UNCLASSIFIED DOCUMENTS ON CIVIL DEFENSE. Levey, Joanne S.; Klein, Ann S.; Hatcher, Bobbie-Jean (eds.) (Oak Ridge National Lab., Tenn.). Apr. 1968. Contract W-7405-eng-26. 178p. Dep. CFSTI.

Five hundred and sixty-three unclassified, unlimited-distribution documents from the Civil Defense Research Library are provided with four indexes: Bibliographic, Key Word, Corporate Author, and Author. (auth)

21499 (TID-5360(Suppl.6)) A SUMMARY OF INDUSTRIAL ACCIDENTS IN USAEC FACILITIES, 1965-1966. (Division of Operational Safety (AEC), Washington, D. C.). Dec. 1967. 49p. GPO $0.35.

Information on Types A and B radiation exposures and industrial accidents occurring during 1965-1966 within the AEC or AEC-owned and -operated contractor operations is presented. Short narrative descriptions on all Types A and B accidents or incidents involving radioactive material and of all fatalities are also included. (B.G.D.)

21500 MEASUREMENTS WITH A LIQUID WHOLE BODY COUNTER OF A REPRESENTATIVE GROUP OF THE SWISS POPULATION. Poretti, G. G.; Waser, P.; Zuppinger, A. (Univ., Berne. Univ., Zurich). Radiol. Clin. Biol., 36: 129-40(1967).

The radioactive content of about 5,500 visitors to the Swiss

National Exhibition in Lausanne (April to October, 1964) was measured with a liquid whole body counter. The content of ^{137}Cs, ^{40}K, and ^{226}Ra was measured for two min, and the distribution of the activity according to sex, age and different regions of Switzerland was calculated with an IBM computer. The results show a general increase of the cesium content; typical differences in potassium content between males and females were also detected. Precise determinations of the radium content were not possible owing to unfavorable measurement conditions in the exhibition hall. It is concluded that a liquid scintillation counter is a very suitable instrument for rapid and precise measurements of radioactivity in large groups of a population. (auth)

21501 ATTENUATION IN THE CHEST WALL OF 20 keV X-RAYS FROM AN INHALED RADIOACTIVE AEROSOL. Rundo, J.; Taylor, B. T.; Booker, D. V.; Newton, D.; Scargill, D. (Atomic Energy Research Establishment, Harwell, Eng.). Nature (London), 217: 642-3(Feb. 17, 1968).

External counting of the low intensity L uranium x rays (energies 13.6, 16.9, and 20.2 keV) is a promising technique for estimation of insoluble plutonium compounds in the human lung. These low energy radiations are, however, very easily absorbed in the tissues of the chest wall, the half-value thickness being about 0.7 cm for soft tissue and 0.03 cm for bone. The effects of variations in body build are clearly important, but difficult to assess, and calibration of the counting equipment is a severe problem. One approach was the use of a phantom or cadaver, but in neither case is there any certainty that radiation from Pu inserted in the chest cavity will undergo the same attenuation by surrounding tissues as in vivo. With the advent of monodisperse aerosols of labeled polystyrene particles, suitable for inhalation, it is possible to study the Pu calibration problem in vivo, using nuclides that decay by orbital electron capture and thus emit characteristic x rays. Some studies are described employing 17 day ^{103}Pd, which emits the characteristic K x rays of rhodium (K_α at 20.2 keV, K_β at 22.8 keV), and is thus very suitable as a component of mock plutonium. Experimental details are described. (UK)

21502 CONTENT OF ^{90}Sr AND ^{137}Cs IN MEAT-BONE MEAL PRODUCED IN 1966. Vrigazov, A.; Marinov, V. Vet. Sb., 64: No. 2, 33(1967). (In Bulgarian).

Determination of the content of ^{90}Sr and ^{137}Cs in meat-bone meal produced in Bulgaria in 1966 indicated that resorption of these isotopes by hogs and chickens, which receive the largest amounts of meat-bone meal with their feed, could not have contributed significantly to the radioactive contamination of foodstuffs as a result of use of meat-bone meal in feed. (JPRS)

21503 APPARATUS FOR PROPORTIONING THE DOSES OF SOLUTIONS OF RADIOACTIVE SUBSTANCES UNDER CONDITIONS OF WORK WITH SHIELDING BOXES. Mitskevich, S. I. Zdravookhr. Beloruss., No. 10, 83-4(1966). (In Russian).

The dispensary received a 4B-OS-A type glove box for diagnostic purposes that proved to be relatively unsuitable for pouring isotope solutions, particularly ^{131}I. Remote dosing with the aid of a dosimeter is not practical in view of the cumbersome size of this glove box. Hence, a simpler and more convenient dosing apparatus is described that allows the dosing of any amount of a solution: a pressurized polyglucin flask is filled with a liquid radioactive substance and a system of glass and rubber tubes with a T-piece for admitting the liquid to the graduated section of the pipette is inserted into the flask stopper. The liquid enters the graduated pipette when the stopcock is in an open position. Pressure on the liquid is assured by squeezing a rubber bulb. The flask with the radioactive substance can be stored within the glove box, in a lead container, and may be used at any moment for pouring. (auth)

21504 CONTAMINATION OF WATERS IN ATHENS BY LONG-LIVED ISOTOPES. Mimikos, N.; Douvoyiannis, J. Chim. Chrow. (Athens, Greece), 31A: 77-80(1966). (In Greek).

The content of long-lived radioisotopes, i.e., ^{90}Sr, ^{137}Cs, and ^{144}Ce, in the waters of Lake Marathon and the city of Athens are presented for the period November, 1964 to October, 1965. A statistical analysis of the fluctuations observed in the values obtained indicated that the radioelements were not removed by purification procedures; the values obtained were less than maximum permissible concentration. (tr-auth)

21505 PROTECTING THE EYESIGHT FROM SOLAR RADIATION. Gorodinskii, S.; Skachkov, Yu. Aviat. Kosmonavt., No. 7, 88-90(1967). (In Russian).

The use of a dual filter is recommended to protect human eyesight from permanent injury caused by solar radiation in space. One element of such a filter would selectively screen the original radiation so as to alter its spectral composition to that encountered on the earth's surface; the other (a gray filter) would limit the total intensity of light to an acceptable limit. The spectral composition of solar radiation in space and on earth was determined for the range of ultraviolet to infrared, and the percentage of elimination required of the selective filter element at various wavelengths was calculated. For a lunar-based observer, such a filter would have to be combined with a uniform gray element capable of eliminating all but 15% of radiation reflected from steep walls of craters and escarpments. For observing from outside the surface of a space ship (albedo of 0 to 100%), the gray filter should be capable of 50-fold reduction of the reflected radiation. (ATD) (TSS)

21506 RADIATION LOAD TO THE GONADS IN DIAGNOSTIC AND THERAPEUTIC PROCEDURES. Koren, K.; Maudal, S.; Flatby, J.; Berteig, L. (Statens Institutt for Stralhygiene, Oslo). Acta Radiol., Ther., Phys., Biol., 6: 385-403(Oct. 1967).

The gonad doses resulting from diagnostic and therapeutic roentgen procedures in Norway during the period 1959 to 1964 were surveyed. Measurements were undertaken in ten roentgendiagnostic departments, six therapy departments, in a childrens clinic, and in some smaller establishments. Examinations of the femur, hip, pelvis, lumbosacral spine, and the lower gastrointestinal tract, as well as urologic and obstetric examinations, contributed almost 90% of the total diagnostic genetic dose. Treatments of the lumbosacral spine and men's knees contributed with 50% and 25%, respectively, to the total therapeutic genetic dose. (auth)

21507 TRANSPORT OF RELATIVELY INSOLUBLE MATERIALS FROM LUNG TO LYMPH NODES. Thomas, Robert G. (Lovelace Foundation, Albuquerque, N. Mex.). Health Phys., 14: 111-17(Feb. 1968).

That concentration of relatively insoluble materials in the lung appears to bear a time dependent linear logarithmic relationship to that in the pulmonary lymph nodes was shown with experimental data from inhalation of compounds of uranium, thorium, plutonium, and polonium by man, dog, or rat. Theoretical functions based upon various postulates were derived for predicting the concentration of materials in lung and lymph nodes following inhalation exposure. Calculations based upon single and double exponential functions yield ratios between the two sites which closely approximate those from experimental studies. A long half-life component is postulated for lung (10,000 days) and an infinite residence time in lymph nodes was assumed. Even though complicated biological processes may be involved in the transport from lung to lymph nodes, until they are better understood it appears that simple schemes like those presented could be employed. (auth)

21508 PREDICTING THE ^{137}Cs INTAKE FROM MILK OF A HUMAN POPULATION AFTER A SINGLE, SHORT-TERM DEPOSITION OF THE RADIONUCLIDE. Lengemann, F. W.; Wentworth, R. A.; Hiltz, F. L. (New York State Veterinary Coll., Ithaca). AT(30-1)-2147. Health Phys., 14: 101-9(Feb. 1968).

A rapid means of assessing the human dose-commitment of ^{137}Cs following a nuclear incident is presented. The important advantage is that calculations rest upon knowledge of milk levels rather than upon values of surface contamination of pasture, which are most difficult to obtain and interpret. The effects of practical countermeasures are also discussed. (auth)

21509 RADIATION DOSE MEASUREMENTS. THEIR PURPOSE, INTERPRETATION, AND REQUIRED ACCURACY IN RADIOLOGICAL PROTECTION. Symposium, Stockholm, 12th–16th June 1967. Paris, European Nuclear Energy Agency, 1967. 598p. (In English and French). (CONF-670621).

Separate abstracts were prepared on 36 papers that discuss radiation dose measurements for radiological protection. (C.H.)

For abstracts of individual papers see: 21322, 21361–21363, 21431, 21510–21539, and 22534.

21510 THE BASIS OF THE ICRP RECOMMENDATIONS ON PERSONNEL MONITORING. Lindell, Bo (National Inst. of Radiation Protection, Stockholm). pp 27-34 of Radiation Dose Measurements. Their Purpose, Interpretation, and Required Accuracy in Radiological Protection. Paris, European Nuclear Energy Agency, 1967.

From Symposium on Radiation Dose Measurements, Their Purpose, Interpretation, and Required Accuracy in Radiological Protection, Stockholm. See CONF-670621.

The recommendations of the ICRP, contained in ICRP Publication 9(1965), concerning personnel radiation monitoring are discussed. It is pointed out that the new text refers only to adults exposed to radiation in the course of their work and to exposure of the public to radiation. The maximum permissible dose (MPD) to workers under normal operating conditions, where the critical organs are the bone marrow and gonads, recommended is 5 rems yr. The dose limitation for the public recommended is one-tenth

of the annual occupational MPD. The recommendations are discussed with regard to operational procedures. (C.H.)

21511 TECHNICAL PROBLEMS POSED BY APPLICATION OF ICRP RECOMMENDATIONS. Jammet, H. P. (Commissariat a l'Energie Atomique, Fontenay-aux-Roses, France). pp 35-45 of Radiation Dose Measurements. Their Purpose, Interpretation, and Required Accuracy in Radiological Protection. Paris, European Nuclear Energy Agency, 1967. (In French).

From Symposium on Radiation Dose Measurements, Their Purpose, Interpretation, and Required Accuracy in Radiological Protection, Stockholm. See CONF-670621.

Applications of the ICRP recommendations for radiation dosimetry, particularly those given in Publication 9, raise a number of technical problems. As the dose limits are set for the whole-body and for particular organs, the dose measurement made on workers need to be interpreted in terms of absorbed doses to the organs. It is therefore necessary to consider a system of translating the crude data obtained from dosimeters into effective absorbed doses. The dose limits are set in relation to various periods of time, the most common of which is a quarter of a year. Several problems arise regarding the most suitable system of reading and recording dose measurements. The recommendations made in Publication 9 envisage a flexible organization of radiation protection according to whether workers are likely to receive doses below or above 0.3 of the dose limits. It is therefore necessary to resolve the problems relating to the use of collective or individual measurements in order to arrive at a final interpretation in relation to the observance of health norms. In a not inconsiderable number of cases high energy radiations may raise such problems as the choice of quality factors. It must be possible under accident conditions to record the high level of absorbed dose and to know the spatial distribution accurately. All the technical problems raised in this way are such as to deserve having the greatest importance attached to them with a view to obtaining results which are comparable and easily interpreted. (auth)

21512 PURPOSES, REQUIRED ACCURACY, AND INTERPRETATION OF PERSONNEL MONITORING. Keene, A. R. (Battelle-Northwest, Richland, Wash.). pp 49-58 of Radiation Dose Measurements. Their Purpose, Interpretation, and Required Accuracy in Radiological Protection. Paris, European Nuclear Energy Agency, 1967.

From Symposium on Radiation Dose Measurements, Their Purpose, Interpretation, and Required Accuracy in Radiological Protection, Stockholm. See CONF-670621.

Radiation dosimetry is concerned with the measurement of the magnitude and distribution of the energy absorbed in a medium of interest as a result of ionizing radiations. Personnel monitoring is one aspect of radiation dosimetry in which the medium of interest is tissue in man. Personnel monitoring usually includes the estimation of dose equivalent resulting from external radiation sources and from internally deposited radionuclides. A discussion of personnel monitoring is presented that is limited to external exposure to γ and x. Usually personnel monitoring is achieved through the use of suitable dosimeters worn at a selected location on the body. The estimated dose to an individual also may be determined by measuring the exposure rates to which the individual is exposed and then integrating these over the duration of his exposure. With the current state of the art, this latter method may, in some exposure situations, give more accurate estimates of dose equivalent than those obtained from personnel dosimeters. Personnel monitoring in one form or another has been used for about fifty years; initially with somewhat primitive methods in the medical field and evolving with increased usage in some countries with the advent of atomic energy projects. Because the initial beneficial uses of ionizing radiation were in the medical field, it is not surprising that the small air ionization chambers and x-ray film, then commonly used in diagnostic and therapeutic medical procedures, were the initial personnel dosimetry devices for radiation protection purposes. The principal changes that have occurred in these dosimeters have been to increase their reliability and to incorporate features which affected their energy dependence. In the last few years new types of dosimeters based on different physical principles, such as thermoluminescence and radiophotoluminescence, have been developed. It is concluded that the overall accuracy of personnel monitoring for assessing the control of externally received radiation from x and gamma sources is adequate. Conservative biases in dose evaluation could be reduced through use of new detector types which eliminate some unwanted responses. Unnecessary inconsistencies in calibration practices cause avoidable inaccuracies in the estimation of the aggregate dose of personnel received at different establishments. (C.H.)

21513 ROLE OF THE FILM BADGE IN PERSONNEL DOSIMETRY. Jones, B. E. (Radiological Protection Service, Belmont, Eng.). pp 59-70 of Radiation Dose Measurements. Their Purpose, Interpretation, and Required Accuracy in Radiological Protection. Paris, European Nuclear Energy Agency, 1967.

From Symposium on Radiation Dose Measurements, Their Purpose, Interpretation, and Required Accuracy in Radiological Protection, Stockholm. See CONF-670621.

The objectives to be achieved by any form of personnel dosimeter for external radiation are discussed. It is concluded that, insofar as the majority of monitored persons are concerned, not only is it not practicable to determine the doses received by internal body organs, but it is also not essential, and a measurement of the dose to the body surface is adequate for protection purposes. The advantages and disadvantages of the film dosimeter for measurements of the dose from β, γ, or x radiation are discussed. It is pointed out that the modern film dosimeter enables the type and energy of the radiation to which it has been exposed to be identified. In cases of accidental over-exposure to radiation the personal dosimeter may be the only indication that such an exposure has occurred and may be of assistance in determining the nature of the accident. The film badge is particularly valuable for the latter purpose due to its unique feature of recording, two dimensionally, the spatial distribution of the radiation falling upon it. (C.H.)

21514 ROLE OF THERMOLUMINESCENT DOSIMETERS IN PERSONNEL DOSIMETRY. Cameron, J. R.; Suntharalingam, N. (Univ. of Wisconsin, Madison). pp 71-85 of Radiation Dose Measurements. Their Purpose, Interpretation, and Required Accuracy in Radiological Protection. Paris, European Nuclear Energy Agency, 1967.

From Symposium on Radiation Dose Measurements, Their Purpose, Interpretation, and Required Accuracy in Radiological Protection, Stockholm. See CONF-670621.

Recent investigations indicate that thermoluminescence dosimetry (TLD) has considerable promise for applications in personnel radiation dosimetry. The high accuracy, good reproducibility, wide usable range of radiation exposure, long-term stability of the stored information and good re-usability are some of the advantages of the TLD technique. The phosphors which have been studied most are lithium fluoride, calcium fluoride, and calcium sulphate. Lithium fluoride has the advantage that it is approximately tissue-equivalent and its response is nearly energy independent. Further, it shows negligible fading of the stored information. Calcium fluoride has a higher sensitivity but because of the relatively high effective atomic number its response is very energy dependent. One type of calcium fluoride exhibits three prominent peaks in the glow curve at well separated temperatures. This provides the possibility of obtaining multiple readings from the same dosimeter. This particular phosphor has also been shown to respond to uv light, and the light induced thermoluminescence is proportional to the previous integrated radiation dose received. This feature affords a simple way of assessing the accumulated integral radiation exposure. Calcium sulphate possesses very high sensitivity and has been used to measure micro-roentgen levels of exposure. However because of the relatively low temperature at which the thermoluminescence appears, it has the undesirable characteristic of showing considerable loss of stored signal at room temperature. Recently, TLD systems have acquired an increasing importance in personnel dosimetry, as a suitable replacement for the conventionally used film-badge. Various solid and packaged TLD systems have been developed. Many comparative studies have been undertaken and the results clearly demonstrate the advantages of the TLD technique. Certain institutions are now beginning to use a TLD system for routine monitoring under field conditions. One large establishment in the United States has replaced the film-badge with a TLD system for long-term monitoring. (auth)

21515 BASIC PRINCIPLES AND THE ROLE OF GLASS DOSIMETERS IN PERSONNEL DOSIMETRY. Yokota, R.; Miyanaga, I.; Maruyama, R.; Nishiwaki, Y. pp 87-107 of Radiation Dose Measurements. Their Purpose, Interpretation, and Required Accuracy in Radiological Protection. Paris, European Nuclear Energy Agency, 1967.

From Symposium on Radiation Dose Measurements, Their Purpose, Interpretation, and Required Accuracy in Radiological Protection, Stockholm. See CONF-670621.

By ESR and optical studies of radiophotoluminescence (RPL) centers in silver-activated phosphate glass after γ irradiation, it was found that the silver ions act as traps for both electrons and positive holes, and all these silver centers act as RPL centers. The reason why RPL in these glasses has high stability and build-up after γ irradiation has been clarified. New low-Z glass with higher sensitivity and better durability to weathering has been developed. The remarkable uniformity of the sensitivity of the glass has been established. A transistorized fluorimeter which has higher accuracy and sensitivity to γ rays and lower sensitivity

to dirt on the glass and its holder has been developed. Consequently, reproducibility and sensitivity have been considerably improved. Thermal neutrons and coexisting γ rays can be more conveniently measured by using both lithium-7 glass and natural lithium glass as a pair. The energy dependency and directional dependency of dosimeters are discussed. The use of the 6 × 6 × 3.3 mm^3 glass dosimeter as a monitor for the finger gave satisfactory results in the case of plutonium nuclear fuel operation. The application of glass dosimeters to personnel monitoring is discussed in comparison with other dosimeters. (C.H.)

21516 PHYSICAL INTERPRETATION OF DATA PROVIDED BY PERSONNEL DOSIMETRY. Soudain, G.; Portal, G.; Duhamel, F. (Commissariat a l'Energie Atomique, Paris). pp 109-29 of Radiation Dose Measurements. Their Purpose, Interpretation, and Required Accuracy in Radiological Protection. Paris, European Nuclear Energy Agency, 1967. (In French).

From Symposium on Radiation Dose Measurements, Their Purpose, Interpretation, and Required Accuracy in Radiological Protection, Stockholm. See CONF-670621.

The choice of methods for interpreting results obtained with photographic personal dosimeters is discussed. The reader/interpreter instrument used is described. Results when the dosimeter was irradiated by simple or composite electromagnetic radiation of different hardness, or by mixed radiation made up either of γ and β radiation or γ radiation and neutrons are reported. (C.H.)

21517 EXPERIENCES FROM A CENTRAL DOSIMETRY SERVICE USED AS A SURVEY "INSTRUMENT" BY AN INSPECTION AGENCY. Snihs, J. O.; Hedgran, A.; Pettersson, B. G. (National Inst. of Radiation Protection, Stockholm). pp 131-6 of Radiation Dose Measurements. Their Purpose, Interpretation, and Required Accuracy in Radiological Protection. Paris, European Nuclear Energy Agency, 1967.

From Symposium on Radiation Dose Measurements. Their Purpose, Interpretation, and Required Accuracy in Radiological Protection, Stockholm. See CONF-670621.

The National Institute of Radiation Protection, Stockholm, operates a film dosimetry service providing films regularly for about 2,000 persons. Altogether about 50,000 films are evaluated per year. This institute is also the authority responsible for radiation protection in Sweden and there is close collaboration between the dosimetry service and the inspection activity. The major interest has been directed to occasional higher-than-normal exposures indicating a possible need for protective actions. In view of the very low exposures observed in most fields of work, less attention has been paid to the follow-up of accumulated individual doses. Due to this policy, the amount of administrative work and record-keeping has been kept low both within the service and for its users. (auth)

21518 INDIVIDUAL DOSIMETRY OF EXPOSED PERSONNEL IN THE INDUSTRIAL SECTORS AND MEDICAL ESTABLISHMENTS OUTSIDE NUCLEAR CENTERS. Delhove, J. (Controlatom, Brussels). pp 137-49 of Radiation Dose Measurements. Their Purpose, Interpretation, and Required Accuracy in Radiological Protection. Paris, European Nuclear Energy Agency, 1967. (In French).

From Symposium on Radiation Dose Measurements, Their Purpose, Interpretation, and Required Accuracy in Radiological Protection, Stockholm. See CONF-670621.

Legislation in Belgium relating to the protection of the population and workers against the dangers of ionizing radiations requires that doses received by workers exposed in the course of their jobs be monitored. In particular, the personal dosimetry requirements of users in the industrial sector and medical establishments outside the large nuclear establishments are examined. Criteria concerning the nature of radiation, measurement ranges, accuracy of measurement, and interpretation are presented. These criteria are put into practice satisfactorily by the organization of a centralized dosimetry service using commercial film badges and thermoluminescent dosimeters. The service is operated by a body approved by the Ministry for the monitoring of installations emitting ionizing radiations. (auth)

21519 INTERCOMPARISON OF RESULTS FOR FILM, GLASS, AND IONISATION CHAMBER DOSIMETERS WORN TOGETHER IN ROUTINE PERSONNEL MONITORING. Piesch, E. (Karlsruhe Nuclear Research Centre, Ger.). pp 151-80 of Radiation Dose Measurements. Their Purpose, Interpretation, and Required Accuracy in Radiological Protection. Paris, European Nuclear Energy Agency, 1967.

From Symposium on Radiation Dose Measurements, Their Purpose, Interpretation, and Required Accuracy in Radiological Protection, Stockholm. See CONF-670621.

Results are discussed from intercomparison measurements with different personnel dosimeters as worn together by one and the same person for routine personnel monitoring in an isotope laboratory. Usual calibration irradiations allow only the determination of the measuring accuracy under selected given conditions. Hence, in order to state the reproducibility and reliability of personnel dosimeters under field conditions as met in practical personnel monitoring, about twenty persons wore three different types of dosimeter (film, photoluminescent, glass, and ionization chamber dosimeters) on adjoining parts of the trunk and additionally two dosimeters of the same type (pairs of dosimeters). After each four week period, the dosimeters were evaluated by three different laboratories. Altogether, about 300 irradiations during the routine work of the dosimeter wearers lead to dose values between 40 mR and 1 R. The comparison measurements showed that the film dosimeter, as compared with energy independent dosimeter types, seem to be highly susceptible to errors under the conditions of practical personnel monitoring, especially in presence of different radiation components and undefined irradiation incidence. Energy independent measuring methods gave better accuracy for a reproducible dose measurement in routine personnel dosimetry. (auth) (TSS)

21520 IS FILM DOSIMETRY STILL A VALID TECHNIQUE FOR USE IN PERSONNEL MONITORING? Wachsmann, F. (Gesellschaft fuer Strahlenforschung mbH., Neuherberg, Ger.). pp 181-9 of Radiation Dose Measurements. Their Purpose, Interpretation, and Required Accuracy in Radiological Protection. Paris, European Nuclear Energy Agency, 1967.

From Symposium on Radiation Dose Measurements, Their Purpose, Interpretation, and Required Accuracy in Radiological Protection, Stockholm. See CONF-670621.

For about twenty five years film dosimeters have been used in personnel monitoring as permanent long term dosimeters. Their limits and disadvantages, however, are well known. Only in recent years have other dosimetric systems, especially solid state dosimeters such as the fluorescence or the thermoluminescence dosimeter, found more and more favor. Apart from certain clear advantages, however, even these systems have their limits. A critical comparison of the properties of the different dosimeters shows that the most important advantage of the film dosimetry technique is the large amount of information obtained. Its value in identifying the causes of dose exposures and enabling these to be avoided in the future is explained. This shows that film dosimetry is still a valid technique for use in personnel monitoring. Combined dosimeters are described which enable the advantages of the film and solid state dosimeters to be used simultaneously. With regard to dosimetry in accident conditions, however, photoluminescent glass dosimeters may today offer optimal possibilities. (auth)

21521 FACTORS INVOLVED IN ESTABLISHING FILM DOSIMETER PERFORMANCE CRITERIA. Larson, H. V.; Unruh, C. M.; Beetle, T. M.; Keene, A. R. (Battelle-Northwest, Richland, Wash.). pp 191-201 of Radiation Dose Measurements. Their Purpose, Interpretation, and Required Accuracy in Radiological Protection. Paris, European Nuclear Energy Agency, 1967.

From Symposium on Radiation Dose Measurements, Their Purpose, Interpretation, and Required Accuracy in Radiological Protection, Stockholm. See CONF-670621.

Battelle–Northwest is conducting a study for the United States Atomic Energy Commission to develop film dosimeter performance criteria that will promote and verify good technical performance in personnel film dosimeter services. Current capabilities of both private and government processors were established by exposing film dosimeters from 37 processing laboratories in the United States, including 11 private, 15 Atomic Energy Commission, and 9 military processors. Selection of types, spectra, and dose equivalent ranges for the test exposures was based on the most common sources of external radiations that are handled in both industry and medicine, on the maximum permissible dose equivalents established by the International Commission on Radiological Protection, and on past experience. Photon energies of 17, 100, and 170 keV, and isotopic sources of radium and ^{60}Co were used to provide a range of energies for the test exposures. The exposures included x and γ rays in the dose equivalent range from 0.05 and 600 rem, thermal and fast neutrons in the range from 0.05 and 0.80 rem, and β rays in the range from 0.10 to 0.50 rem. Several mixtures of radiation that are commonly found in industrial work were also included in the study. A statistical model and program was developed to yield the most valid measurement of performance with a minimum of test exposures. Types of film packets, calibration sources, and geometries of calibration exposures currently used by film dosimeter processors in the United States were summarized from a questionnaire that was completed by each participant. The practical limitations, current practices, and testimony of experts were also major factors used in establishing the performance criteria. (auth)

21522 MEASUREMENT OF CONTAMINATION ON THE WRAPPING PAPER OF PERSONAL FILMS AS A CONTROL OF WORKING HABITS. Berg, O.; Grande, P.; Vig, B. (Radiation Hygiene Lab., Copenhagen). pp 203-8 of Radiation Dose Measurements. Their Purpose, Interpretation, and Required Accuracy in Radiological Protection. Paris, European Nuclear Energy Agency, 1967.

From Symposium on Radiation Dose Measurements, Their Purpose, Interpretation, and Required Accuracy in Radiological Protection, Stockholm. See CONF-670621.

Personal photographic film dosimeters from work with open radioactive sources very seldom show external exposure. The reason for this is the small amount of radioactivity permitted to be handled as open sources, due to the risk of internal contamination. Evaluating the extent of contamination and thereby also the risk of internal irradiation can be done by means of measuring the contamination of the wrapping paper on personal films. Experience shows that approximately 10% of the personal films from such work have dark spots usually showing splashes of radioactive solutions from the sink or the waste bucket where the radioactive material has been disposed of. The contaminant can often be identified by measuring the wrapping paper by a multi-channel pulse height analyzer. The personal film is a very sensitive contamination detector, e.g., clearly showing a spot containing 1 pCi of ^{131}I. For this reason contaminated films are very often found. The spots are regarded by many observers as spoiling the results making difficult an exact evaluation of the external exposure. The information gained in this way, however, is very useful and can in many cases give a good picture of bad working habits and technique. (auth)

21523 INTERNATIONAL EXPERIMENT OF COMPARISON AND STANDARDIZATION OF DOSIMETRIC FILMS. Recht, P.; Collet, M. (EURATOM, Brussels). pp 209-25 of Radiation Dose Measurements. Their Purpose, Interpretation, and Required Accuracy in Radiological Protection. Paris, European Nuclear Energy Agency, 1967. (In French).

From Symposium on Radiation Dose Measurements, Their Purpose, Interpretation, and Required Accuracy in Radiological Protection, Stockholm. See CONF-670621.

In 1965 the Health Protection Division of the Euratom Commission decided, in collaboration with the competent authorities in the member countries, to carry out a general calibration and comparison of the dosimetric films used in the various centers of the Community. The experiment was carried out using films for monitoring x and γ radiations. Three ranges of exposure were used, each being allocated to one specialized center in the Community. On four occasions the film badge service sent 25 films for each of the three ranges to the respective three centers without previous knowledge of the nature or extent of the exposure to be applied. The Health Protection Division compared the film readings with the exposures used. Comments are presented on the results of this long series of experiments. They enabled significant improvements to be made in the quality of film readings, and also provided an exact indication of the degree of reliability of the information usually provided. The experiment was extended to almost all the organizations responsible for radiation dosimetry in the countries of the European Community. (auth) (TSS)

21524 INTERPRETATION OF RESULTS OF INDIVIDUAL DOSIMETRY AND DOSE EVALUATION AT THE ORGAN LEVEL. Mechali, D. (Commissariat a l'Energie Atomique, Fontenay-aux-Roses, France). pp 227-39 of Radiation Dose Measurements. Their Purpose, Interpretation, and Required Accuracy in Radiological Protection. Paris, European Nuclear Energy Agency, 1967. (In French).

From Symposium on Radiation Dose Measurements, Their Purpose, Interpretation, and Required Accuracy in Radiological Protection, Stockholm. See CONF-670621.

The recommendations of the International Commission on Radiological Protection and most national regulations relating to the irradiation of various body organs or tissues state that the doses received by these organs or tissues should enable dose measurement for external irradiation to be derived. The information necessary for this evaluation includes physical data on the conditions of exposure (nature, energy, fluency, and the angle of incidence of the particles on the various parts of the body) and anatomical data (shape, size, composition, and position of the various organs or tissues in the body). A few studies will enable the doses received by organs or critical tissue to be evaluated in simple cases (exposure of the whole-body to a uniform radiation field of known nature and energy). However, the information necessary for such an evaluation is often not available. In particular, personal dosimeters are only worn in limited numbers and when, as is quite frequently the case, exposure is not uniform, each dosimeter only gives information about the exposure of a limited part of the body. In practice, two cases must be distinguished. These include: I. The evaluation of doses during routine monitoring. The doses received are low; the aim of monitoring is not so much to evaluate accurately the doses received by the various organs, as to ensure that they are below fixed limits. As a general rule, this objective may be attained by a simple and cautious interpretation of the readings of dosimeters worn on the part of the body which is likely to be most exposed. II. The evaluation of doses after considerable exposure. The determination of doses received by the various organs or tissues is then of real interest. It will be based on data obtained from personal dosimeters, area dosimeters, and from examination of the subject. It will often be necessary to reconstruct the exposure situation. (auth)

21525 ACCURACY OF METHODS AND INTERPRETATION OF RESULTS OF H-3 MONITORING. Maushart, R. (Karlsruhe Nuclear Research Centre, Ger.). pp 541-57 of Radiation Dose Measurements. Their Purpose, Interpretation, and Required Accuracy in Radiological Protection. Paris, European Nuclear Energy Agency, 1967.

From Symposium on Radiation Dose Measurements, Their Purpose, Interpretation, and Required Accuracy in Radiological Protection, Stockholm. See CONF-670621.

Tritium in the human body can be assessed with a high degree of accuracy by measurements of tritium excreted in urine if the measurements are not longer than some weeks after the initial intake and if the measurements are repeated sufficiently so that the half-time of excretion will be known. Later measurements have to take into account that the fraction of total-body tritium contained in the body water decreases with time. Protection of the worker should include both air concentration measurements and urine measurements, but regular urine control is strictly necessary. Especially for chronic exposures more information would be needed about the long-time behavior of tritium in the body. (auth)

21526 USE OF ENERGY-INDEPENDENT DOSIMETERS FOR MEASURING PARTIAL AND WHOLE-BODY DOSES. Johns, T. F. (Atomic Energy Establishment, Winfrith, Scotland). pp 241-54 of Radiation Dose Measurements. Their Purpose, Interpretation, and Required Accuracy in Radiological Protection. Paris, European Nuclear Energy Agency, 1967.

From Symposium on Radiation Dose Measurements, Their Purpose, Interpretation, and Required Accuracy in Radiological Protection, Stockholm. See CONF-670621.

Dose information can be obtained from LiF thermoluminescent dosimeters without the use of filters, and the question arises whether such dosimeters are at a disadvantage compared with film badges for the measurement of partial and whole-body radiation doses in that they do not also provide spectrometric data from which organ doses can be calculated. Energy-independent dosimeters are especially suitable for finger-tip dosimetry, where the incorporation of filters in a dosimeter is impracticable. A simple dosimeter containing LiF indicates the dose under about 25 mgm/cm^2 of tissue, irrespective of whether it is due to x rays, γ, or β radiation. Similar dosimeters (with perhaps the addition of a simple filter to distinguish penetrating radiation from β radiation) are also very valuable for measuring the exposure of different parts of the body in situations where the exposure is particularly non-uniform, and especially where the dose is mainly due to β radiation. In the case of general exposure of the body, direction of irradiation is more important than radiation quality in determining the relationship between organ dose and surface dose. Even if a dosimeter is worn (on the front of the body) which measures both dose and radiation quality, estimates of critical organ doses made from the data may be seriously in error unless the direction of irradiation is also known; the errors are greatest when the irradiation is from behind. This difficulty can best be overcome by wearing more than one dosimeter, but this is not necessary if it can reasonably be assumed that the wearer is normally exposed from in front or equally from all directions. In the latter case a simple energy-independent dosimeter worn on the front of the body gives an adequate measure of the more important critical organ doses (except at low photon energies where it tends to overestimate them). Consequently simple LiF dosimeters are not only useful for measuring doses to finger-tips or other parts of the body, but can be used as an alternative to film badges for demonstrating general compliance with ICRP recommendations on critical organ doses. (auth) (TSS)

21527 INTERPRETATION OF RESULTS OF PHYSICAL DOSIMETRY BY MEANS OF BIOLOGICAL DOSIMETRY. Lafontaine, A. (Ministere de la Sante Publique et de la Famille, Brussels). pp 255-60 of Radiation Dose Measurements. Their Purpose, Interpretation, and Required Accuracy in Radiological Protection. Paris, European Nuclear Energy Agency, 1967. (In French).

From Symposium on Radiation Dose Measurements, Their Purpose, Interpretation, and Required Accuracy in Radiological Protection, Stockholm. See CONF-670621.

Whatever the degree of physical accuracy it may achieve, dosimetry leaves open the problem of the actual dose transferred to the body tissues or systems. The possibility of using changes induced in the cell or tissue structure as a biological dosimeter is discussed. It is pointed out that this would have the advantage of being independent of the type of radiation and would avoid the difficulties of interpreting physical measurements into biological effects. Such an approach could, in addition, be of great value in cases of accidental exposure where it is not possible to provide a system of physical dosimetry measurement (particularly in the case of nonprofessional exposures) and in certain cases of local exposure where the amount of dose received is difficult to determine. Among the techniques which seem hopeful for use as biological dosimeters, the caryogram of cultured leukocytes is perhaps the most promising. (auth) (TSS)

21528 ACCURACY OF DOSIMETRY CONSISTENT WITH VARIANCES IN BIOLOGICAL DAMAGE. Franke, Th.; Hunzinger, W. (European Company for the Chemical Processing of Irradiated Fuels, Mol, Belgium). pp 261-72 of Radiation Dose Measurements. Their Purpose, Interpretation, and Required Accuracy in Radiological Protection. Paris, European Nuclear Energy Agency, 1967.

From Symposium on Radiation Dose Measurements, Their Purpose, Interpretation, and Required Accuracy in Radiological Protection, Stockholm. See CONF-670621.

The ultimate purpose of radiation dosimetry is not to compare dose equivalents actually received by an individual or one of his organs with some recommended or imposed permissible values, but rather to check whether biological damage is likely to develop in that individual. Provided the biological damage can be measured quantitatively and a sufficient number of observations is available, then a variance of the damage can be derived. Secondly, if it can be assumed that damage is strictly proportional to the dose equivalent over the entire range of doses interest, then the variance of the biological damage is also proportional to the variance of the dose equivalent. From this latter variance the precision with which a dose measurement should be carried out can be derived. Two applications are considered: the genetic hazards of ionising radiation, and the shortening of the life-span. Results show that a minimum precision of ±40% in measuring the annual dose equivalents of radiation workers is necessary to be consistent with the variance of the genetical changes of the population; and a precision of ±75% is sufficient in order to be consistent with the natural variance of the life-span. Thus it is shown that radiation dosimetry as it is currently applied, is sufficiently precise, at least for external dosimetry, particularly if the dose equivalents received by a radiation worker over many years are determined as the sum of many short interval doses individually measured. (auth)

21529 PURPOSE AND INTERPRETATION OF PERSONNEL MONITORING DATA FOR HIGH ENERGY ACCELERATORS. Baarli, J.; Dutrannois, J. (CERN, Geneva). pp 275-92 of Radiation Dose Measurements. Their Purpose, Interpretation, and Required Accuracy in Radiological Protection. Paris, European Nuclear Energy Agency, 1967.

From Symposium on Radiation Dose Measurements, Their Purpose, Interpretation, and Required Accuracy in Radiological Protection, Stockholm. See CONF-670621.

The problems associated with personnel monitoring near high-energy accelerator installations are reviewed. It is shown that due to the complexity and variety of the radiation fields existing near such accelerators particular problems are met with in personnel radiation monitoring. In spite of the lack of suitable detectors for direct measurements of the dose equivalent, valuable information can be obtained by conventional devices. By specifying the information required, a review of possible practical methods for personnel monitoring near high energy accelerators is given. Examples to illustrate the problems are taken from measurements near the CERN large accelerators. A detailed description is given of the CERN personnel monitoring system which is based on the use of a package containing one neutron and one gamma film. The interpretation of the recorded data is extensively discussed in the light of phantom measurements and radiation survey measurements made near the large accelerators. Particular difficulties arise in the interpretation since one is obliged to evaluate doses caused by radiation energies exceeding the classical values given in existing recommendations. The phantom measurements were also used to establish critical organ doses and their variations due to changes of radiation composition. Comparison of survey data and personnel monitoring data are presented to show the validity of recorded personnel doses. It is concluded that a considerable lack of knowledge exists at present in making reliable personnel monitoring measurements of unknown radiation fields near high energy accelerators. On the other hand, if present techniques are combined with knowledge of the radiation, quite reliable results can be obtained. This is confirmed by examples where the results obtained are in agreement with careful physical measurements. (auth)

21530 ROLE, INTERPRETATION, AND ACCURACY OF MEASUREMENT OF FAST NEUTRONS BY MEANS OF PHOTOGRAPHIC EMULSIONS. Cavallini, A.; Busuoli, G. (Comitato per l'Energia Nucleare, Bologna). pp 293-315 of Radiation Dose Measurements. Their Purpose, Interpretation, and Required Accuracy in Radiological Protection. Paris, European Nuclear Energy Agency, 1967.

From Symposium on Radiation Dose Measurements, Their Purpose, Interpretation, and Required Accuracy in Radiological Protection, Stockholm. See CONF-670621.

In the past ten to fifteen years nuclear emulsions have come into general use in the field of personnel fast neutron dosimetry. The method has intrinsic characteristics and limitations: the useful response restricted to a narrow energy range, energy-dependence, latent image fading, gamma sensitivity, and track recognition liable to judgment of the observer. Nevertheless, nuclear emulsions are still the most widely used, although new dosimetric techniques (some of them very promising) have been found and remarkably improved. The interpretation of film reading results is discussed with the aim of assessing the dose delivered to personnel. The general criteria followed in film reading by dosimetric services in many countries are discussed and compared, with particular consideration to the requirements of each service. (auth)

21531 PURPOSES, INTERPRETATION, AND REQUIRED ACCURACY IN RADIATION MONITORING OF THE WORKING ENVIRONMENT. Cowper, G. (Atomic Energy of Canada Ltd., Chalk River, Ont.). pp 345-54 of Radiation Dose Measurements. Their Purpose, Interpretation, and Required Accuracy in Radiological Protection. Paris, European Nuclear Energy Agency, 1967.

From Symposium on Radiation Dose Measurements, Their Purpose, Interpretation, and Required Accuracy in Radiological Protection, Stockholm. See CONF-670621.

The purposes, interpretation, and accuracy required in the radiation monitoring of the working environment must continue, as always, to be based upon the best understanding of the adverse effects of ionizing radiation upon man. The consensus of the best available expert opinion has led to the Recommendations of the International Commission for Radiological Protection, and in the matter of formulating controls and carrying out practices for the monitoring of the working environment these Recommendations must always be kept in mind. The purpose in radiation monitoring is to assist the users of radiation to have the highest productivity and safe, satisfactory working conditions. The accuracy of measurements and the interpretations drawn from them must be designed to accomplish this purpose. (auth) (TSS)

21532 OBJECTIVES AND INTERPRETATIONS OF CONTROL OF ZONES IN NUCLEAR INSTALLATIONS. Candes, P.; Barthoux, A. (Commissariat a l'Energie Atomique, Paris). pp 355-63 of Radiation Dose Measurements. Their Purpose, Interpretation, and Required Accuracy in Radiological Protection. Paris, European Nuclear Energy Agency, 1967. (In French).

From Symposium on Radiation Dose Measurements, Their Purpose, Interpretation, and Required Accuracy in Radiological Protection, Stockholm. See CONF-670621.

In nuclear installations involving potential radioactive hazards, it is essential to carry out permanent monitoring of radioactivity in order to ensure that the operating personnel and the surrounding populations do not receive radiation doses higher than the permissible limits. The problem is complex because hazards may very often appear at very different points that are difficult to forecast inside buildings, and may involve a number of people permanently working in the premises. With regard to the surrounding populations, the difficulties are of a different order because, while the location of the source is generally well known and while the distribution of the population is statistically stable, the contamination path is affected by complex phenomena and it is very difficult to forecast the nature and extent of the hazard. The basis on which these various checks should be carried out; the role attributed to instantaneous response detectors, which of necessity only give summarized information; the role attributed to measuring instruments which, although accurate, will probably supply information after the event; and the complex problem of interpreting the data, with a view to evaluating as accurately as possible the hazards run by those involved, are discussed. (auth) (TSS)

21533 ORGANIZATION OF SURVEILLANCE AND CONTROL OF WORKING ENVIRONMENT BY APPLICATION OF FRENCH REGULATIONS. Pellerin, P.; Chanteur, J.; Moroni, J. P. (Ministere des Affaires Sociales, Paris). pp 365-81 of Radiation Dose Measurements. Their Purpose, Interpretation, and Required Accuracy in Radiological Protection. Paris, European Nuclear Energy Agency, 1967. (In French).

From Symposium on Radiation Dose Measurements, Their Purpose, Interpretation, and Required Accuracy in Radiological Protection, Stockholm. See CONF-670621.

The experience gained over the last seven years by the Service Central de Protection Contre les Rayonnements Ionisants (Central Service for Protection against Ionizing Radiation) in the field of personal dosimeters, relates to a large number of workers (10,000 photographic film dosimeters a month at the present time). Unlike staff grouped together in nuclear centers, these workers are scattered in small groups over the whole of French territory, and include a high proportion of hospital staff, who are generally more exposed to radiation than industrial staff. The technological organization of the monitoring services is described, and its specific requirements for determination of type of exposure, calibration of dosimeters, conditions for wearing dosimeters, development, reading, and interpretation of personal dosimeters, and measures taken in the event of the maximum permitted dose being exceeded are discussed. (auth) (TSS)

21534 TYPE TESTS FOR RADIATION PROTECTION DOSIMETERS. TECHNICAL REQUIREMENTS AND RESULTS OF MEASUREMENTS MADE IN COMPLIANCE WITH A GERMAN DRAFT RADIATION PROTECTION REGULATION. Huebner, W. (Physikalisch-Technische Bundesanstalt, Brunswick). pp 383-90 of Radiation Dose Measurements. Their Purpose, Interpretation, and Required Accuracy in Radiological Protection. Paris, European Nuclear Energy Agency, 1967.

From Symposium on Radiation Dose Measurements, Their Purpose, Interpretation, and Required Accuracy in Radiological Protection, Stockholm. See CONF-670621.

The German Government is preparing a regulation for the type-testing and approval of radiation protection Geiger–Mueller dose-rate meters to be used for legally prescribed measurements of environmental or personal dose-rate levels from photons and fast electrons. The Physikalisch-Technische Bundesanstalt (PTB) will carry out these tests which will be applied for by the manufacturer, who will be required to indicate in the instructions for use for what ranges of energy, angle of radiation incidence, temperature, and dose rate the particular instrument will observe the prescribed tolerance. The PTB will have to investigate factors and quantities influencing the response and to ascertain the individual errors as well as the total error of measurement. Such factors are: particle energy, angle of radiation incidence, dose-rate, temperature, air pressure (for ionization chambers), battery voltage, after effect, spatial orientation of the instrument, warm up time, adjustment time, and zero drift. An investigation of a reliable ionization exposure rate meter, commercially available, has shown that the total error is about ±35%. Although all errors are systematic errors, in most cases the user is not able to correct the reading for all of these because he does not have enough information about the radiation field when making measurements or on the extent of the other influencing factors. Therefore, it would be unrealistic to fix too small tolerances within which local or personal doses shall be calculated. The manufacturer will be obliged by the regulation to give accurate information and to develop more efficient instruments, while the user will be able to obtain instruments fit for his special purposes with a guaranteed margin of error. A type test will be extensive and expensive but the periodic checks on individual instruments of an approved type will be rather more simple. (auth)

21535 CONFIDENCE LIMITS ON MEASUREMENTS IN THE WORKING ENVIRONMENT. Wheatley, B. M. (Central Electricity Generating Board, Berkeley, Eng.). pp 415-24 of Radiation Dose Measurements. Their Purpose, Interpretation, and Required Accuracy in Radiological Protection. Paris, European Nuclear Energy Agency, 1967.

From Symposium on Radiation Dose Measurements, Their Purpose, Interpretation, and Required Accuracy in Radiological Protection, Stockholm. See CONF-670621.

Monitoring a working environment is shown to yield data from which personal doses can only be roughly estimated, sometimes with very large margins of error. It is important to realize that monitoring does not lead directly to a dose estimate which can be compared with ICRP limits. In the simplest case the monitoring instrument responds linearly to a physical parameter of the radiation field such as fluence or exposure. Very large instrumental errors are common because of inadequate investigation of energy responses, or of failure to realize the extent of the spectrum being measured. However, even with a perfect instrument further errors of up to a factor of ten in dose estimation can occur in interpretation depending, among other considerations, on the directional properties of the field and the position of the worker in it. Concrete examples are given of both kinds of error. In other cases the instruments do not respond linearly to a simple physical parameter. Some have an energy response which approximates to a particular curve (e.g., the ICRP dose-fluence curve in the case of neutron rem-meters) so that the accuracy of their interpretation is limited by the assumptions made. Further, some instruments have an arbitrary response determined by the properties of a particular detector. It is shown that measurements with such instruments are often valuable provided that confidence limits are recognized. The characterization of a radiation field in order to provide estimates of skin dose is briefly discussed with reference to the errors of interpreting results of measurements with different detectors. Emphasis is placed on results obtained using ionization chambers and Geiger–Mueller detectors. Problems involved in the dosimetry of thermal neutrons are discussed. Having suggested the sources and magnitudes of errors in estimating dose by interpreting measurements of field parameters, confidence limits for a variety of installed and portable monitors are discussed. These are compared with the confidence limits which are desirable in different circumstances, and it is suggested that although present monitoring techniques can provide adequate data, there is a danger that a large number of poor measurements may be made, with misleading claims of accuracy, in substitution for a smaller number of carefully interpreted measurements. (auth) (TSS)

21536 PERSONAL AIR SAMPLING AND MULTIPLE STAGE SAMPLING; INTERPRETATION OF RESULTS FROM PERSONAL AND STATIC AIR SAMPLERS. Schulte, H. F. (Los Alamos Scientific Lab., N. Mex.). pp 495-510 of Radiation Dose Measurements. Their Purpose, Interpretation, and Required Accuracy in Radiological Protection. Paris, European Nuclear Energy Agency, 1967.

From Symposium on Radiation Dose Measurements, Their Purpose, Interpretation, and Required Accuracy in Radiological Protection, Stockholm. See CONF-670621.

Personal air samplers were developed to provide breathing zone sampling of radioactive aerosols for workers who do non-repetitive tasks and move about in doing these tasks. They have definite limitations in flow rate and total duration of sampling. They give a much better estimate of the quantity of contaminant breathed than any reasonable number of fixed samplers in the work area. The disturbing fact demonstrated by the use of these samplers is the higher concentrations found as compared with conventional samplers and the doubts these results cast on previous sampling results. The personal sampler, too, is limited in its ability to provide accurate data for the estimation of the internal dose to an individual. Multistage samplers were developed in an attempt to obtain better data on the quantity of contaminant actually reaching the pulmonary region of the lungs. While a specific deposition pattern is assumed by ICRP in calculating permissible concentration levels, the actual distribution of deposition in the respiratory tract is determined by the particle size distribution of the contaminant. Corrections for this can be made if the particle size distribution is determined but such determinations are laborious. The multistage sampler is supposed to make this correction in a simple manner. Its limitations, however, are not always understood. The reliability of information obtained by these advanced sampling techniques is discussed and the method of interpreting the data is presented. The discussion is based on actual filed data obtained with these instruments. (auth)

21537 OBJECTIVES OF AIR MONITORING AND THE INTERPRETATION OF AIR SAMPLING RESULTS. Langmead, W. A. (United Kingdom Atomic Energy Authority, Harwell, Eng.). pp 475-93 of Radiation Dose Measurements. Their Purpose, Interpretation, and Required Accuracy in Radiological Protection. Paris, European Nuclear Energy Agency, 1967.

From Symposium on Radiation Dose Measurements, Their Purpose, Interpretation, and Required Accuracy in Radiological Protection, Stockholm. See CONF-670621.

The objectives of monitoring for radioactive aerosols in the working environment are reviewed. It is pointed out that it is important to distinguish between the four main aims that include: sampling to determine the general levels of air contamination in the working environment under normal conditions; early warning sampling, using alarm devices, to detect important increases in the level of air contamination in the working area; sampling to establish upper limits of personal exposure in suspected cases of acute intakes; and sampling in the early stages of operation of new plant to ascertain whether plant design and operational procedures are adequate for safe working. The suitability of the conventional static air sampler as a device for providing meaningful data for the control of personal exposure is discussed in

relation to various types of aerosol and working environment. Measurements made with personal air samplers of the air contamination in the breathing zones of some groups of workers has enabled factors to be determined which, when applied to current ICRP maximum permissible concentrations, provide criteria against which the long-term averages of the results from static air samplers may be compared to demonstrate compliance. Various methods of processing air sampling data are considered, for example in the determination of the correlation between static and personal air sampling results. Measurements of the particle size distributions of aerosols encountered in establishments of the United Kingdom Atomic Energy Authority are discussed. The application of these data to allow modified values of maximum permissible concentration (mpc) is suggested. Further modifications to the current ICRP values permitted by the lung model proposed by the ICRP Taks Group on Lung Dynamics are considered in relation to the particular aerosols discussed. Preliminary data on the spatial and temporal variation of particle size distributions in the work space, measured with the Harwell cascade centripeter, are also given. (auth) (TSS)

21538 SOURCES OF ERROR INHERENT IN THE METHODS OF AIR MONITORING FOR INHALED RADIO-ACTIVE MATERIALS. Breslin, A. J. (Atomic Energy Commission, New York). pp 511-25 of Radiation Dose Measurements, Their Purpose, Interpretation, and Required Accuracy in Radiological Protection. Paris, European Nuclear Energy Agency, 1967.

From Symposium on Radiation Dose Measurements, Their Purpose, Interpretation, and Required Accuracy in Radiological Protection, Stockholm. See CONF-670621.

Two kinds of errors are pertinent in routine monitoring programs for radioactive aerosols. These include the sampling errors which relate to the accuracy of each separate measurement of dust concentration, and the errors associated with estimating average concentrations from groups of samples. The sampling error depends upon the quality of instrumentation and technique. It can be quite small, as little as 10 to 15%, but is not necessarily so, there being circumstances in which considerably greater sampling errors are possible. Very large errors can occur in estimates of average dust concentrations because of the inherent instability of dusty atmospheres in work areas. It has been difficult to estimate the magnitude of these errors much less prescribe means of restricting the errors to some acceptable limits. But the application of statistical methods promises to rectify this problem. By statistical methods, errors can be evaluated retrospectively. Before the value of the prospective use of statistics can be ascertained, more must be learned about the characteristics of sample distributions in typical occupational areas. Special investigations of occupational exposure may require more precise measurements than are obtained in routine monitoring for which certain approximations are implicitly accepted. The dependence of fractional intake and biological fate of air contaminants on particle size, solubility, and chemical form must be taken into account if precise dosimetric data are needed. Particle charge has also been shown to affect fractional intake although its significance in occupational exposures not known. (auth)

21539 ATMOSPHERIC CONTROL IN URANIUM MINES. Pradel, J. (Commissariat a l'Energie Atomique, Fontenay-aux-Roses, France). pp 527-40 of Radiation Dose Measurements, Their Purpose, Interpretation, and Required Accuracy in Radiological Protection. Paris, European Nuclear Energy Agency, 1967. (In French).

From Symposium on Radiation Dose Measurements, Their Purpose, Interpretation, and Required Accuracy in Radiological Protection, Stockholm. See CONF-670621.

The ICRP recommends maximum permissible concentration for radon in uranium mines of 3×10^{-8} $\mu Ci/cm^3$ for 40 hours' work per week, daughter products being assumed to be present in the quantities found in unfiltered air. This limit is calculated by assuming that 10% of the RaA atoms are in the free atom state. The appropriate definition of free atoms is given, followed by the results of measurements that show that under experimental conditions less than 1% of free atoms are found in the mine. It is suggested that the maximum permissible concentration should be fixed by taking into account the dose received from the larger particles, which settle deeper in the bronchus. Calculations show that at this level fairly high doses are attained which would seem to call in question the premises of the calculation, including deposition phenomenon in the bronchus, thickness of mucosa, radiosensitivity of epithelial cells. In the absence of accurate values derived from calculations, experience must be taken as a basis. In French mines, over a 15-year period, mean concentrations of the order of 2×10^{-7} $\mu Ci/cm^3$ were found to be well tolerated by the body. Recent publications, giving accounts of accidents in mines, confirm that 3×10^{-7} $\mu Ci/cm^3$ is a limit which should not be exceeded. In spite of the inaccuracy of the standards, dependable control requires strict compliance with the values chosen, and for this reason highly systematic monitoring must be used. Its efficiency depends much more on its strictness of application than on the choice of the magnitude measured, such as radon concentration, free atom concentration, or potential α energy. The methods used in French mines are described. (auth) (TSS)

Medicine

Refer also to abstracts 21146, 21372, 21485, 21506, 21571, 21573, 21575, 21576, 21581, 21582, 21586, 21595, 21596, 21614, and 21615.

21540 (ACRH-1000-34) BONE SCANNING. Gottschalk, Alexander (Chicago Univ., Ill.). Sept. 1967. Contract AT(11-1)-69. 10p. (CONF-670958-1). Dep. CFSTI.

From Conference on Nuclear Medicine: Current Status in Medical Practice, Cleveland, Ohio.

The properties of the four most commonly used bone scanning agents, ^{47}Ca, ^{18}F, ^{85}Sr, and ^{87}Sr, are summarized in a table. The properties listed are half-life, gamma energy, chemical form, dose, usual time starting scan, and patient dose. Advantages and disadvantages of bone scanning agents are discussed. It was found that in cancer patients with indication of bone metastases, 60% of those with negative roentgenograms had positive bone scans, whereas only about 20% of those with roentgen lesions had negative bone scans. The rationale for bone scanning is examined and evaluated, and future developments of the technique are suggested. (H.L.W.)

21541 DETECTION OF BONE METASTASES OF CARCINOMA OF THE MAMMARY GLAND BY INVESTIGATIONS OF THE UPTAKE OF ^{85}Sr. Bek, V.; Janko, L.; Vyhnanek, L.; Kolar, J.; Drapelova, D.; Babicky, A. (Charles Univ., Prague). Cas. Lek. Cesk., 106: 329-33(Mar. 31, 1967). (In Czech).

Study of 54 patients with cancer of the mammary gland showed that uptake of ^{85}Sr is indicative of bone metastases. Out of the 54, only in 3 was Sr uptake doubtful and clinical finding negative, and in 2 Sr negative and the findings positive. Strontium-85 can be used for early diagnosis and therapy may be started sooner than otherwise possible. (TSS)

21542 THE EFFECT OF LUNG TISSUE ON THE EXIT DOSE IN 33-MeV PHOTON THERAPY. Holsti, L. R.; Anttila, P. (Univ. Central Hospital, Helsinki). Radiol. Clin. Biol., 36: 141-52(1967).

The central axis dose of the exit field was measured with Sievert Bg-ionization chambers during 33 MeV photon therapy of patients with lung carcinoma. The dose was compared with the corresponding dose measured in water phantom. Their ratio, that denotes the magnitude of the correction factor of isodoses determined in standard conditions, was studied as a function of the thickness of lung tissue penetrated by irradiation. The lung tissue thickness was determined from anterior-posterior and lateral chest x-ray pictures and from transverse tomograms. The exit dose was 22 to 38% greater than the calculated dose for the maximum lung tissue thicknesses. Individual differences were demonstrated and they were found to be caused partly by the condition of the lung, emphysema, and fibrosis. (auth)

21543 THE PARTICIPATION OF KININS IN THE PATHOGENESIS OF EARLY DISTURBANCES IN THE SKIN CAPILLARY PERMEABILITY IN LOCAL β-RAY IRRADIATION. Oyvin, I. A.; Uklonskaya, L. I.; Gaponiuk, P. J. (Medical Radiology Inst., Obninsk, USSR). Experientia, 23: 555-6(July 15, 1967).

Three areas of shaved abdominal skin of rabbits were β-irradiated ($^{90}Sr-^{90}Y$) in doses of 1660, 4750, and 9500 rad. Evans blue was administered for observation of changes in capillary permeability. Dimedrol and dimebolin were administered intramuscularly 30 min before the irradiation. EAC was given intravenously and trasylol intraperitoneally one hour before the irradiation. The most pronounced inhibitory action was obtained with trasylol and the least with dimebolin. It is possible to explain the protective action of trasylol and EAC in β-ray inflammation of the skin by the inhibition of kinin formation, and the activity of dimedrol and dimebolin by the inactivation of kinins that have already been formed. (H.L.W.)

21544 MANAGEMENT OF AN EXTENSIVE PLUTONIUM WOUND AND THE EVALUATION OF THE RESIDUAL INTERNAL DEPOSITION OF PLUTONIUM. Larson, H. V. (Battelle Memorial Inst., Richland, Wash.); Newton, C. E. Jr.; Baumgartner, W. V.; Heid, K. R.; Crook, G. H. Phys. Med. Biol., 13: 45-53 (Jan. 1968).

When an acute internal exposure to plutonium occurs a number of problems arise for consideration by the treating physician and the attending physicist. A plutonium wound incident at Hanford,

involving the laceration of an employee's arm by plutonium fragments, emphasized these problems and the need for great care in wound and patient management, both from a medical and physical standpoint. The methods of wound management are described, including surgical removal of the plutonium; use of chelating agents, and the methods of evaluating the residual deposition of plutonium. Some areas of needed research are indicated. (auth) (UK)

21545 CHEMICAL PROTECTION AGAINST IONIZING RADIATION. V. MEASUREMENTS OF THE EXTENT OF NECROSIS AS AN INDEX OF THE PROTECTIVE EFFECT OF CHEMICAL SUBSTANCES AGAINST RADIATION IN CROCKER SARCOMA IN MICE. Stachura, Jerzy; Niezabitowski, Aleksander; Zebro, Tadeusz; Jorasz, Elzbieta; Szczepkowski, Tadeusz (Polish Academy of Sciences, Krakow). Patol. Pol. 17: 475-82(1966). (In Polish).

The histological changes observed in irradiated Crocker sarcoma of white mice, and necrosis measurement results, which may serve as an index both of the degree of damage to the irradiated tumor as well as of the protective effect of a specific chemical agent (sodium cysteinesulfonate) against such damage are discussed. Planimetric measurements of necrosis were performed in the transplantable Crocker sarcoma of 64 white mice locally irradiated by X-rays, after previous administration of sodium cysteinesulfonate (CTS), and without such preliminary treatment. The mice were divided into one control group and three experimental groups, differing in terms of radiation exposure and CTS dosage. In the group of animals treated with CTS before radiation, necrosis was found to be far less extensive than in the case of animals subjected to radiation without such preliminary protective treatment. Post-irradiation histological lesions in the tumors protected with CTS were also strikingly less pronounced. (ATD)

21546 BASIC ASPECTS OF BRAIN TUMOR LOCALIZATION BY RADIOACTIVE SUBSTANCES: A REVIEW OF CURRENT CONCEPTS. Bakay, Louis (Buffalo General Hospital). J. Neurosurg., 27: 239-45(Sept. 1967).

Interpretation of scans obtained with various radioisotopes and labeled compounds, especially ^{203}Hg-chlormerodrin, ^{131}I-albumin, ^{99m}Tc-pertechnetate, ^{68}Ga-edathamil, ^{64}Cu, ^{74}As, and ^{206}Bi, is surveyed, with 35 references. Frequently, the reason for a positive brain scan was the regional absence or greatly increased permeability of the blood-brain barrier. Brain tumors, particularly glioblastomas and metastatic tumors, contained abnormal blood vessels. The uptake of radioactive substances by brain tissue adjacent to tumor was frequently much greater than that of distant brain and often equal to that of the tumor itself. One reason for the difference in the uptake of various substances by tumor and normal brain tissue could be the different size of their extracellular compartments. Various studies with labeled substances such as ^{32}P, ^{64}Cu, and ^{74}As, revealed that the concentration or specific activity of these isotopes in brain tumors was similar to their concentration in liver, kidney, pancreas, and other parenchymatous organs. Although ^{131}I-albumin was taken up by the cells through pinocytosis, ^{74}As and ^{131}I were predominantly extracellular in location, and ^{64}Cu, ^{206}Bi, and ^{203}Hg-chlormerodrin were mostly intracellular. Data obtained from the scanning of neoplastic and non-neoplastic lesions with ^{203}Hg-chlormerodrin suggested that this distribution was not merely a reflection of tumor metabolism. These and other data indicated that the blood-brain barrier was based on selective membrane permeability with a reduction or loss of selectivity in cerebral lesions. (BBB)

21547 PROTECTION AGAINST LETHAL IRRADIATION INJURY BY PANCREATIC ENZYME EXCLUSION. Sokol, Anthony B.; Lipson, Leon W.; Morgenstern, Leon; Hiatt, Nathan (Cedars-Sinai Medical Center, Los Angeles). Surg. Forum, 18: 387-9(1967).

Pancreatectomy reduces the intensity of the response of the small intestine to a lethal dose of radiation. The lessened injury of the small intestine is associated with a significant increase in postradiation survival time. Removal of the pancreas seems to protect the bone marrow from the effects of radiation. (auth)

21548 USE OF LYSOZYME IN LEUKOPENIA DUE TO IONIZING RADIATIONS. Bernardi, L.; Mainoldi, F. (Univ., Bologna). Minerva Radiol., Fisioter. Radiobiol., 12: 325-36 (Sept. 1967). (In Italian).

Lysozyme was employed in leukopenia from ionizing radiations of various types, on 28 patients treated at the third section of Radium Institute of Bologna University for neoplasms of different seats (in most cases of the gynecological organs). These patients were selected among 844 cases aiming to deal with subjects in which the leucocytary crasis during treatment with Lysozyme could not be influenced by drugs or pathological processes, eventually modifying the results of the research. Lysozyme was administered by intravenous injections with daily doses of 1 g, and in 26 out of 28 cases it was able to restore the leukocytary rate at satisfactory levels, without having to stop the radiological treatment. It may be of some interest to point out that in six cases submitted to a lengthy course of radiotherapy and in which the number of leukocytes was again reduced, a subsequent treatment with Lysozyme resulted in the increase of white cells. (auth)

21549 CHANGES IN GLUTATIONE AND SULFO-HYDRILE GROUPS IN THE PROCESS OF ELIMINATION OF HARMFUL AFTEREFFECTS OF X IRRADIATION OF SEEDS. Fang, I-wei; Liu, Ta-cho; Lo, Tsung-lo. Chih Wu Sheng Li Hsueh Pao, 2: 161-70(1965). (In Chinese).

Seeds of the mungo bean and peas were soaked for six hours in water, and then exposed to x rays in doses of 700 and 800 roentgens. The irradiation caused a delay in germination, the growth of roots began only after the seventh day. By the twelfth day of germination, however, the irradiated seeds also had branch roots, although their length was less than that of the control seeds. Parachloromercurobenzonate (PCMB) alone reduced the number of branch roots only by 1 to 2% after two hours of treatment, but after irradiation, PCMB significantly increased the harmful effect of the x rays. In accordance with the degree of germination, the content of free SH groups decreased, in irradiated seeds particularly. The glutathione content did not change in the first 24 hours after irradiation. It is presumed that the glutathione and SH groups are not broken down directly in the process of irradiation. Content of the SH groups was significantly decreased only beginning with the fifth day after irradiation. Before the appearance of branch roots, the glutathione content in irradiated plants was greater than in the control plants, but this difference became equalized by the twelfth day. Under the influence of irradiation the protein content did not change, but the content of SH groups (ν equiv. for 1 gram of protein) increased by the tenth day of germination to 118.1 against 73.4 for the control. The value of the ratio SH-S-S was 1.0 in the control plants and 1.7 in the irradiated plants. On the basis of the obtained facts, the authors reach a conclusion that the glutathione and SH groups play an important role in the process of eliminating harmful consequences of irradiation. (auth)

21550 IN VITRO STUDIES ON THYMUS AND LUNG DIFFERENTIATION FOLLOWING URETHAN TREATMENT. Globerson, Amiela; Auerbach, Robert (Univ. of Wisconsin, Madison). pp 3-19 of Methodological Approaches to the Study of Leukemias. Defendi, Vittorio (ed.). Philadelphia, The Wistar Institute Press, 1965.

From Wistar Inst. Symposium on Human Leukemias, Philadelphia, Apr. 5-6, 1965. See CONF-650443.

The in vitro effect of urethan on mouse embryonic thymus and lung explants from x-irradiated mice is described. Thymus explants after urethan treatment showed extensive necrosis accompanied by a complete loss of lymphoid cells. Regeneration did not occur even after prolonged periods of cultivation in urethan-free medium. Addition of bone marrow to urethan-treated thymus explants led to recovery of thymus lymphoid organization. The effect of bone marrow was transmitted across an intervening millipore filter barrier, suggesting an inductive role of the bone marrow. This effect was not duplicated either by embryonic liver or submandibular gland. Urethan treatment stopped embryonic lung development and caused disruption of alveolar organization. Restitution did not occur upon subsequent cultivation in urethan-free medium. Addition of salivary gland mesenchyme or lung mesenchyme induced epithelial proliferation and differentiation of urethan-treated lung tissue. This effect was not duplicated by bone marrow. It is suggested that inductive tissue interactions similar to those involved in normal morphogenesis may play a role in the restitution of damage caused by urethan. (auth)

21551 ON THE MECHANISM OF AET RADIOPROTECTION. Grigorescu, S.; Nedelcu, C.; Nastase, M.; Gheorghe, N.; Apostolescu, R. Radiobiol. Biol. Mol., 69-82(1967). (In Rumanian).

In order to specify the functional changes induced by the chemical radioprotective agent, 2-(2-aminoethyl)-2-thio-pseudourea (AET-HBr), in mammals, a study was made on the effect of AET-HBr activity on ^{32}P and ^{131}I-triiodotyronine uptake in rats. The uptake of ^{35}S-AET under the effect of cysteine and epinephrine was followed by histologically ascertained AET radioprotection, as against ^{35}S-AET uptake. Radioprotection by AET against the histologically recorded x ray dose of 900 R was not consistent with the amount of ^{35}S-AET accumulated in the organs examined. The organs that accumulated a high amount of ^{35}S-AET were not protected, whereas those showing reduced accumulation were protected against radioinduced lesions. Administration of AET 20 minutes prior to ^{32}P uptake strongly inhibited the accumulation of the latter in the bones. No modifications were recorded if the substance was administered one hour after ^{32}P uptake.

This effect, however, was transitory. Uptake of ^{131}I-triiodothyronine in the examined organs, particularly in the intestine was inhibited by AET. Cysteine inhibited intenstinal and bone uptake of ^{35}S-AET. Such an effect was not observed with epinephrine. The results obtained indicate the important role played by the direct activity of AET on the cell. (auth) (Romanian Sci. Abstr.)

21552 ACCIDENTAL INJECTION INTO FINGER TIP IN PREPARATION PROCEDURE OF ^{239}Pu SOLUTION. Etoh, Hideo (National Inst. of Radiological Sciences, Chiba, Japan). Hoken Butsuri, 2: 116-20(Mar. 1967). (In Japanese).

An internal exposure accident took place on March 10, 1966, at the National Institute of Radiological Sciences when a research worker was engaged in preparation and fractionation procedures of a ^{239}Pu solution. A 37-yr old man accidentally injected a contaminated needle into his left forefinger during a glovebox procedure. The radioactivity of the contaminated portion of the finger was rapidly and accurately determined, and radiation hazards were reduced to a minimum by surgical removal of the contaminated tissue and administration of a chelating agent. The circumstances, causes, and medical and health physics aspects of the accident are described. (NSA of Japan) (TSS)

21553 METHOD OF TESTING A FOCUSSED COLLIMATOR FOR RADIOISOTOPE SCANNING. Saito, Hiroshi; Watanabe, Yo-ichi (Nagoya Univ. School of Medicine, Japan). Radioisotopes (Tokyo), 17: 71-4(Feb. 1968). (In Japanese).

X-ray films sandwiched between methacrylate plates were exposed through holes of a collimator vertically or horizontally to the gamma ray beam of ^{131}I kept in the place of a NaI(Tl) crystal. The results showed the leakage of gamma rays through 6 corners of weak shielding of a 5 cm focus collimator, which was built for the scanning of ^{131}I in tissues. However the leakage disappeared when the shielding was reinforced by inserting lead casts to the central holes. A 10 cm focus collimator showed a longer and narrower focus than the 5 cm focus collimators. This test does not need scanner, therefore the results are simple, reproducible, and useful for the comparison, and planning of collimators. (auth)

21554 THE FREQUENCY OF CHROMOSOME ABERRATIONS IN THE BONE MARROW CELLS OF MONKEYS OF VARIOUS AGES FOLLOWING IRRADIATION AND UNDER CONDITIONS OF RADIOPROTECTION. Sysoeva, O. A. (Inst. of Biological Physics, Moscow. Inst. of Experimental Pathology and Therapy, Sukhumi, USSR). pp 79-84 of Vliyanie Ioniziruyushchikh Izluchenii na Nasledstvennost'. Dubinin, N. P. (ed.). Moscow, Izdatel'stvo Nauka, 1966. (In Russian).

Monkeys (Macaca rhesus) were x-irradiated with 100 R at a dose rate of 3 R/minute. The animals, one-, three to four-, and eight to ten-years old, received 4 ml of cysteamine solution (20 mg/kg of weight) 20 to 30 minutes before irradiation. Bone marrow specimens were taken 5, 12, and 24 hours after irradiation and the frequency and character of chromosome aberrations were determined in anaphase. It was found that the cytogenetic radiosensitivity of the bone marrow cells depended on age, being greatest at eight to ten years, least at three to four years, and intermediate at one year. Cysteamine had a considerable protective action. The percentage of aberrant cells decreased after 5 to 24 hours in both protected and unprotected animals. Chromosome translocations were observed in animals of all age groups, mainly 12 and 24 hours after irradiation. The number of single fragments was much larger than that of other types of aberrations. (JPRS)

21555 RADIOPROTECTIVE ACTION OF THIOLS ON HUMAN CELLS IN A TISSUE CULTURE. Manuilova, E. S. pp 151-6 of Vliyanie Ioniziruyushchikh Izluchenii na Nasledstvennost'. Dubinin, N. P. (ed.). Moscow, Izdatel'stvo Nauka, 1966. (In Russian).

The protective properties of thiourea against γ radiation were demonstrated in a primary culture of human embryo fibroblasts when thiourea was introduced 1 hr before irradiating the culture with a dose of 50 R. The average degree of protection for this dose of irradiation was 56% for all fixation periods ranging from 2 to 70 hr postradiation. The greatest effect of protection with respect to chromosome translocations was manifested when the material was fixed 23 to 26 hr after irradiation. A protective effect of thiourea during irradiation with a dose of 25 R was observed only 12 hr after irradiation. (ATD)

21556 ATTEMPT TO INFLUENCE POSTIRRADIATION RETENTION OF STOMACH CONTENTS OF RATS BY APPLICATION OF PAPAVERINE. Visnovskii, P.; Grossmann, V. (Charles Univ., Prague). Cesk. Fysiol., 16: 145-6(Mar. 1967). (In Czech).

Emptying of the stomach contents after irradiation would improve recovery after irradiation. Administration of papaverine produced negative results, and in doses where it could be used therapeutically, it increased the retention time. (JPRS)

21557 INFLUENCE OF A MIXTURE OF RADIOPROTECTORS ON THE CELL RENEWAL IN THE DUODENUM OF X-IRRADIATED MICE. Maisin, J. R.; Lambiet-Collier, M. (Centre d'Etude de l'Energie Nucleaire, MOL, Belgium). Int. J. Radiat. Biol., 13: 35-43(1967).

BALB/c mice pre-treated with a mixture of 2-β-aminoethylisothiouronium-Br-HB(AET), gluthathione, and serotonin were exposed to 1350 R of x rays. The duration of the generation time of the stem cells in the duodenum, the number of labeled or nonlabeled nuclei following administration of ^{3}H-thymidine, the mitosis, the karyorrhectic and pyknotic cells and the migration time of the crypt cells along the villi, were determined. The mixture of radioprotectors diminished the radiation-induced lesions in the stem cells of the small intestine, but did not improve the delayed migration of crypt cells along the villi. This effect on the transit time resulted from an increase in the generation time of the stem cells. It is postulated that the delay of migration of the stem cells along the villi and the protection offered by the mixture of radioprotectors allow the protected intestinal crypts to cover the villi before they become denuded. (auth)

21558 A CASE OF BILATERAL RETICULUM CELL SARCOMA OF THE TESTIS, TREATED BY INTRALYMPHATIC IRRADIATION WITH ^{131}I ETHIODOL AFTER BILATERAL ORCHIECTOMY. Mori, Yoshinori; Takaha, Minato (Osaka Univ.). Hinyokika Kiyo, 13: 149-54(Feb. 1967). (In Japanese).

A case of a 48-year-old man with painless bilateral testicular sarcoma is described. Histological examination revealed reticulum cell sarcoma. He was treated by bilateral high orchiectomy, followed by intralymphatic radioisotope therapy with ^{131}I Ethiodol. During 3 months after irradiation therapy, no generalization of tumor was observed. The incidence of bilateral tumors, and of reticulum cell sarcoma in the tumors, and their therapies are discussed. (NSA of Japan)

21559 SPLEEN SHIELDING IN SURVIVORS OF THE ATOMIC BOMB. Gregory, Peter B.; Milton, Roy C.; Johnson, Marie-Louise T.; Taura, Tadashi (Atomic Bomb Casualty Commission, Hiroshima. Atomic Bomb Casualty Commission, Nagasaki). Radiat. Res., 33: 204-15(1968).

Two hundred and ninety-one heavily scarred survivors of the atomic bombings are included in this study. The results indicate that Hiroshima survivors with scars under the age of 30 at the time of the bomb and exposed to less than 1300 meters from the hypocenter tolerated splenic irradiation poorly. Bone marrow depression and failure secondary to splenic irradiation is offered as the most likely explanation for this finding. It was further noted that splenic irradiation was accompanied by more frequent epilation and fever in survivors with scars who were 30 years or over at the time of the bomb. The conclusions drawn in this paper are based on the assumptions that the orientation of scarred survivors at the time of the bomb with respect to the hypocenter was random, that distance from the hypocenter is a reliable index of exposure, that any shielding was either negligible or distributed uniformly among the scarred population, and finally that any observed effects were actually due to an influence of the spleen. (auth)

21560 POSTIRRADIATION LEUKOCYTE PATTERNS IN MICE AND DOGS TREATED WITH ENDOTOXIN. Ainsworth, E. J.; Mitchell, F. A. (Naval Radiological Defense Lab., San Francisco). Radiat. Res., 33: 325-36(1968).

Since endotoxins are potent stimulators of the hematopoietic system, and hematopoietic recovery after irradiation appears to be accelerated in endoxtoxin-treated mice, the mechanism of endotoxin protection may be closely related to effects on the hematopoietic system. The present studies were conducted to evaluate the effect of endotoxin on the return of leukocyte counts toward normal in irradiated mice and dogs. Typhoid-paratyphoid vaccine was used as the source of endotoxin, and animals were injected 24 hours before x irradiation. The data show that the endotoxin-treated animals had higher numbers of circulatory granulocytes than did controls between approximately 7 and 17 to 21 days after irradiation. The pattern of the return of granulocyte counts toward normal in endotoxin-treated animals was characterized by a large rise during the second week which coincided in time with the abortive rise observed in nontreated animals. The granulocyte counts in endotoxin-treated animals declined after the period of the abortive rise but remained higher than in the nontreated controls and returned to normal earlier than did the counts of the controls. (auth)

21561 PROBLEMS OF CORRECT INTERPRETATION OF RADIOISOTOPE RENOGRAMS: EXPERIMENTAL OBSERVATIONS AND CLINICAL EXPERIENCES. Klapproth, Hans J. (George Washington Univ., Falls Church, Va.). J. Urol., 99: 211-19(Feb. 1968).

After 10 years of investigation and clinical application, radio-

isotope renography has emerged as a valuable diagnostic procedure. However, radioisotope renograms frequently fail to permit a specific diagnosis of the underlying disease and, hence, should be interpreted only in context with other clinical and laboratory information. (auth)

21562 PROTECTION OF MICE BY POSTIRRADIATION TREATMENT WITH A CELL-FREE COMPONENT OF SPLEEN. Ford, Larry C.; Donaldson, David M.; Allen, A. Lester (Brigham Young Univ., Provo). Proc. Soc. Exp. Biol. Med., 127: 286-9(Jan. 1968).

Fractions of Ellinger's cell-free splenic extract administered following a lethal x-ray exposure of mice resulted in 94% survival. This increased survival is greater than has previously been reported with any cell-free preparations given after radiation exposure. The protective agent was found in the second protein peak obtained by gel filtration with Sephadex G-200. The molecular weight of the protective fraction as determined by gel filtration was approximately 70,000. The relative degree of protection induced by this cell-free factor decreased with increasing x-ray doses. (auth)

21563 PHOTOSENSITIZATION OF SEA-URCHIN SPERM TO LONG-WAVE ULTRAVIOLET LIGHT BY PSORALEN. Colombo, G. (Univ. of Perugia, Italy). Exp. Cell Res., 48: 167-96(Oct. 1967).

Sperm of the sea urchin (Paracentrotus lividus) in sea water were treated with psoralen, exposed to 360 mμ uv radiation, or a combination of psoralen and uv radiation. Sperm mobility, as observed under the microscope, did not appear to be impaired by any of the treatments, nor was sperm penetration into eggs affected. The development of eggs fertilized by irradiated sperms or by sperms treated with psoralen but kept in darkness proceeded normally. Embryonic development of eggs fertilized with sperm treated with psoralen and uv radiation was greatly impaired. It was concluded that uv irradiation of psoralen-treated sperm affected the nuclei and DNA. (C.H.)

21564 CHORDOMA. THIRTY-FIVE-YEAR STUDY AT MEMORIAL HOSPITAL. Higinbotham, Norman L.; Phillips, Ralph F.; Farr, Hollon W.; Hustu, H. Omar (Memorial Hospital, New York). Cancer, 20: 1841-50(Nov. 1967).

The clinical histories of 46 cases of chordoma seen and treated at Memorial Hospital from 1930 to 1965 are reviewed, including 30 cases of sacral origin, ten cases of vertebral origin, five sphenoidal and one extranotochordal, with an age range from 2½ years to 71 and a male sex predominance of 32 to 14. Only three patients in this series are alive and free of disease, 5, 13, and 16 years after diagnosis and treatment and the absolute 5-year survival rate with freedom from disease is only 8.7%. Complete surgical excision can result in a cure in a few selected sacrococcygeal or sphenoidal cases but incomplete removal or tumor spillage in the wound are certain to lead to recurrence and probable metastasis and death. When radiation therapy is employed, either alone or preoperatively, symptomatic relief can be expected and some regression in the tumor at least for a time. In those tumors that show some radioresponsiveness repeat x-ray dosages may prove of extended benefit. The authors conclude that distant metastasis and local recurrence are more common than ordinarily considered and therapeutic doses of supervoltage irradiation pre- or postoperatively could be of substantial benefit in the management of this uncommon disease. (auth)

21565 CELLULAR MIXED DISULPHIDES BETWEEN THIOLS AND PROTEINS, AND THEIR POSSIBLE IMPLICATION FOR RADIATION PROTECTION. Modig, H. (Karolinska Institutet Medical School, Stockholm). Biochem. Pharmacol., 17: 177-86 (Feb. 1968).

The occurrence of mixed disulfides between thiols and proteins was demonstrated in crystalline bovine serum albumin and in proteins of Ehrlich ascites tumor cells. The thiols could be released from the proteins by reduction of the disulfide bonds with sodium borohydride. On the average, 25% of the released thiols was glutathione. It is suggested that protein bound glutathione may represent a reservoir of physiological radiation protector. The release of glutathione from cellular proteins by an exchange reaction may be of significance for the radioprotective action of cysteamine. (auth)

21566 CHEMICAL PROTECTION AGAINST X-IRRADIATION BY A NEW REDUCING AGENT 1,4-DITHIOTHREITOL IN MARSUPIAL LEUCOCYTES IN CULTURE. Bick, Y. A. E.; Jackson, W. D. (Univ. of Tasmania, Hobart, Australia). Nature (London), 217: 479-80(Feb. 3, 1968).

Dithiothreitol (DTT) has been suggested as a protective agent for sulphydryl groups against oxidation, but no data have hitherto been reported on this substance as a protective agent against irradiation damage, for which purpose it would appear to be particularly well suited. In the studies described leukocyte cultures of Potorous tridactylus were irradiated in the presence and absence of DTT with a view to determining the protective action against induced chromosome breakage. The low chromosome numbers, and the distinct morphology of the chromosomes in this species, enable an accurate estimation of damage at metaphase to be made. Translocations involving two or more chromosomes can be recognized without ambiguity. Samples of oxygenated blood received 0.5 ml DTT per 5 ml 1 hour before irradiation; irradiation was to 200 R at 100 R/min, at room temperature. Subsequent treatment is described in detail. All cultures gave good mitotic indices and chromosomal damage was estimated as follows: chromatid and isochromatid deletions were regarded as one-hit events, while chromosomal interchanges were regarded as two-hit events. It was found that the presence of DTT significantly decreased chromosome aberrations in irradiated cultures; deletions were reduced by 17%, and two-hit events by as much as 68%. If the damage was calculated as number of hits per cell, the total damage was reduced by one half. It is possible that, like BAL, DTT acts by shortening the time during which chromosome breaks remain open. The similarity in chemical structure between BAL and DTT is noted, each containing two sulphydryl groups. The mechanism of action of sulphydryl compounds in general is briefly discussed. The simplest hypothesis for the action of DTT is that it acts as a reducing agent by almost eliminating the oxygen effect. (UK)

21567 DEPENDENCE OF RADIOPROTECTIVE EFFECT ON THE DOSE OF RADIOPROTECTOR ADMINISTERED. Strelkov, R. B.; Semenov, L. F. (Inst. of Experimental Pathology and Therapy, Sukhumi, USSR). Radiobiologiya, 7: 562-4(1967). (In Russian).

Mexamine (2.5 to 350 mg/kg) and cystamine (5 to 400 mg/kg) were administered to 2150 unpedigreed white mice (males and females) weighing 18 to 20 g subcutaneously in aqueous solution not exceeding 0.6 ml in volume. The animals were γ-irradiated (^{60}Co) at a dose rate of 75 to 55 R/minute for a total dose of 900 R. The survivors were counted on the thirtieth day. The results obtained with cystamine permit recommending the maximum tolerable dose; its effectiveness increased in proportion to the dose administered. Over a large range of protective doses of mexamine, its antiradiation activity did not depend on the dose administered; it had a great breadth of radioprotective effect and it was concluded that it could be used in doses much smaller than the maximum tolerable dose. (JPRS)

21568 EFFECTS OF X-RAYS COMBINED WITH OTHER AGENTS ON THE EXCITABILITY OF FROG SCIATIC NERVE. Seymour, R.; Dawson, K. B. (Royal Marsden Hospital, Sutton, Eng.). Int. J. Radiat. Biol., 13: 171-8(1967).

The increased excitability (measured as a change in amplitude of monophasic sub-maximal action potentials in a humid chamber) of the isolated sciatic nerve of frog to electrical stimulation after a radiation dose of 10 krads of 50 kV x rays was found to be independent of the oxygen content of the atmosphere surrounding the nerve. Increasing the carbon dioxide content of the atmosphere was found to give an apparent increase in the radiation response. However, this increase was due to a radiation reversal of the neural membrane hyperpolarization induced by the carbon dioxide. Increasing the hydrogen ion concentration of the extracellular fluid was found to reduce the radiation response, whereas radiation enhanced the blocking action on the nerve action potential of low concentrations of cocaine. It is postulated that the results of the combined effects of radiation and each of the membrane stabilizers carbon dioxide and cocaine are attributable to a transient increase of intra-membrane pH induced by the radiation. (auth)

21569 RADIOSENSITIZATION BY N-ETHYLMALEIMIDE: OBSERVATIONS WITH SENSITIVE AND RESISTANT STRAINS OF ESCHERICHIA COLI. Bridges, Bryn A.; Munson, R. J. (Medical Research Council, Harwell, Eng.). Int. J. Radiat. Biol., 13: 179-81(1967).

The dose-modifying factors for radiosensitization by N-ethylmaleimide were obtained for a number of bacterial strains related to E. coli B/r and K12. Logarithmic phase bacteria were suspended during γ irradiation at between 0 and 5°C in M medium of Haas and Doudney without glucose, and plated on brain–heart medium solidified with 1.5% purified agar. Oxygen-free nitrogen was bubbled through the suspension for 5 min before and during exposure to ^{60}Co γ radiation. The sensitivity of E. coli B/r under these conditions was about 1/3.1 of the sensitivity when oxygen was bubbled through indicating that a high degree of anoxia was obtained with nitrogen. If the increased sensitivity of normal strains in the presence of NEM is due to the lack of repair of the damage, bacteria deficient in repair should show a small or negligible amount of sensitization. The results showed that,

although the sensitivities of the various strains in anoxic conditions differ by factors of up to 20, the dose-modifying factors obtained with NEM were close to 2.3 with all strains. Possible mechanisms involved in sensitization by NEM are discussed. It was concluded that the absence of any of the known repair or reactivation systems does not affect sensitization by NEM, that DNA is the primary target for lethal radiation damage both in the presence and absence of NEM, but that an addition product of NEM and DNA under the action of radiation is unlikely to be involved. The DNA damage produced by ionizing radiation plus NEM under anoxia affects bacteria in very much the same way as the damage produced in the absence of NEM, which suggests that NEM acts at an early stage after the initial energy-loss event before biologically distinguishable types of damage are formed. (C.H.)

21570 ACTION OF IMIDAZOLE ON HEMATOLOGICAL MODIFICATIONS OF THE IRRADIATED MOUSE. Bernard, Y.; Rinaldi, R. (CEN, Grenoble, France). 16p. (In French). (CONF-650968-2). DTIE.

From European Society for Radiation Biology, Section on Genetical Effects, Annual Meeting, Utrecht.

During the days following exposure to x rays of sample mice and of mice treated by imidazole, the examination of the circulating blood shows a progressive decrease in the number of blood cells, erythrocytes, platelets, and leukocytes. For the leukocytes there is an early and sharp break down that leads to their almost complete disappearance within four days. This decrease occurs in an identical fashion in the sample mice and in the protected mice, but for the protected mice their survival permits a restoration that is almost complete on the 30th day. With respect to the thromboelastographic constants r, k, and Am, their variations are identical for the two groups of mice — increase of r and k and decrease of the maximum amplitude. The rate of fibrinogenesis of the blood is readily increased after irradiation. These results indicate no difference between the two groups of mice with respect to the hematological modifications immediately after irradiation. (tr-auth)

Radiation Effects on Animals

Refer also to 21403, 21417, 21423, 21427, 21429, 21430, 21433–21435, 21437, 21440, 21446, 21448, 21449, 21452–21454, 21458, 21464, 21467, 21468, 21472, 21473, 21477–21485, 21505, 21512, 21527, 21528, 21542–21544, 21548, 21550, 21551, 21554, 21555, 21560, 21563, 21564, 21570, 21626, and 21634.

21571 (COO-910-14) OCCURRENCE AND SIGNIFICANCE OF LYMPHOCYTOSIS IN CATTLE. (Minnesota Univ., St. Paul. Coll. of Veterinary Medicine). Sept. 1967. Contract AT(11-1)-910. 70p. (CONF-670964-1). Dep. CFSTI.

From Conference on the Significance of Lymphocytosis in Cattle, Bethesda, Md.

Data are presented on geographic distribution of bovine leukemia, age distribution of reported cases of bovine leukemia, distribution among breeds of cattle, and effects of environmental and familial factors. Studies were also conducted on the prevalence of lymphocytosis among cattle in Minnesota, hematologic analyses of single case herds of the juvenile and adult leukemia type, and observations pertaining to animals with a marked lymphocytosis originating from multiple case leukemia herds. Treatment of lymphocytosis by gamma radiation was carried out on five cows from high incidence herds. Twenty-four hours after irradiation lymphocytes decreased to 25 to 50% of pre-treatment levels. The maximum reduction of lymphocytes was 28% of pre-treatment levels and was attained by the third post-radiation day. Neutrophils and platelets were also reduced in number. During eight months of the post-radiation period there was a gradual return of lymphocyte numbers to pre-irradiation levels. Animals treated with prednisolone showed 50% of pre-treatment levels of lymphocytes when 6 mg per pound of body weight of prednisolone was given. (H.L.W.)

21572 (LA-DC-9095) VARIABILITY IN THE PARAMETERS USED TO PREDICT THE DOSE TO THE THYROID FROM THE INGESTION OF ^{131}I IN MILK. Stocum, William E. (Los Alamos Scientific Lab., N. Mex.). [1967]. Contract W-7405-eng-36. 44p. (CONF-680108-8). Dep. CFSTI.

From Symposium on Environmental Surveillance in the Vicinity of Nuclear Facilities, Augusta, Ga.

A mathematical model for computing the ^{131}I dose to the thyroid of children is described. The parameters used for the computation are as follows: the total dose to the thyroid from the ingestion of ^{131}I contaminated milk in rads; the ratio of the peak ^{131}I concentration in milk to the cloud dosage, μCi/l per μCi-sec/m^3; the ratio of the total thyroid dose to the peak activity in milk, rads per μCi/l; and the ^{131}I air dosage from the passage of the effluent cloud, μCi-sec/m^3. Factors determining the ratio of the total thyroid dose to the peak activity in milk are as follows: the daily rate of whole milk consumption; the fractional uptake of ^{131}I by the thyroid; the effective half-life of ^{131}I in the thyroid; the effective half-life of ^{131}I in milk; and the weight of the thyroid gland. A discussion of the variability of these factors is presented. (H.L.W.)

21573 (SZS-17/67) MESSUNG DER GONADENDOSIS MAENNLICHER PATIENTEN BEI BECKENAUFNAHMEN, I. V., PYELOGRAPHIEN UND AUFNAHMEN DER LENDENWIRBELSAEULE. (Measurement of the Gonad Dose of Male Patients by Pelvic Exposure, i. v., Pyelographs and Photographs of the Lumbar Vertebra). Golly, L. (Staatliche Zentrale fuer Strahlenschutz, Berlin (East Germany)). Nov. 1967. 14p. Dep.

In a radiodiagnostic department of a large hospital the gonad dose for males was measured by condenser ionization chambers. Descending pyelography, radiography of the pelvis, and of the lumbar spine were investigated. Comparing the experimental values of the different adjustment techniques of the direct exposure field are discussed for various roentgen assistants. The mean dose values are calculated for radiography of the pelvis to 75 ... 524 mR, for descending pyelography to 58 ... 350 mR and for radiography of the lumbar spine to 7 ... 27 mR (with a statistical error less than 5 percent). (auth)

21574 DYNAMICS OF PERIPHERAL BLOOD CHANGES IN CORRELATION WITH COMBINED EXTERNAL RADIATION AND ACTIVATION OF ^{24}Na IN RATS. II. Kofranek, V.; Pospisil, J.; Dienstbier, Z.; Arient, M. (Research Inst. of Irradiation Hygiene, Prague). Cas. Lek. Cesk., 106: 333-41(Mar. 31, 1967). (In Czech).

Changes in leukocytes, neutrophils, lymphocytes, eosinophils, platelets, erythrocytes, hematocrit, and reticulocytes were studied in rats 1 to 29 days after whole-body irradiation with different sources at LD 50/30. Damage of erythropoiesis in bone marrow was detected 24 hours after irradiation. (TSS)

21575 PHOTOSENSITIVITY REACTIONS TO DRUGS. Med. Lett. Drugs Therap., 7: 38-40(May 7, 1965).

Photosensitivity reactions of the skin of man to a variety of drugs are reviewed. (TSS) (BBB)

21576 RADIATION INDUCTION OF SKIN NEOPLASMS IN THE MALE RAT. Jones, D. C.; Castanera, T. J.; Kimeldorf, D. J.; Rosen, V. J. (Naval Radiological Defense Lab., San Francisco). J. Invest. Dermatol., 50: 27-35(Jan. 1968).

Young adult rats exposed to fast neutrons and x rays developed an excessive number of skin tumors. The effect was apparent within eight months of exposure and was associated with a marked increase in the occurrence of malignant tumors of epithelial origin. Graphs are presented to show incidence of various types of tumors in relation to age of rats. Differences occurred between control and irradiated animals with respect to incidence of particular types of tumors and to their location. With high doses of radiation, consistent relationships between tumor incidence and dose or type of radiation were not apparent. (H.L.W.)

21577 IDENTIFICATION OF LYMPHOCYTE CLONES, WITH CHROMOSOME STRUCTURAL ABERRATIONS, IN IRRADIATED MEN AND WOMEN. Court Brown, W. M.; Buckton, Karin E.; Langlands, A. O.; Woodcock, Gillian E. (Western General Hospital, Edinburgh). Int. J. Radiat. Biol., 13: 155-68(1967).

A study was made of the frequency with which two or more cells with an apparently identical stable chromosome aberration are found in preparations of blood cultures from heavily irradiated individuals. A group of 133 patients was examined following exposure to acute doses of x rays or to chronic α and γ irradiation from ^{232}Th in retained Thorotrast. The conditions are discussed in which such cells may be regarded as originating from a lymphocyte clone present in vivo, and four patients were found with unequivocal evidence of a clone. In undertaking comparative studies on irradiated subjects two important considerations appear to be the total number of cells scored with stable aberrations and the age of the subjects. (auth)

21578 BIOLOGICAL CRITERIA INDICATIVE OF THE PROBABILITY OF SURVIVAL OF X-RAY IRRADIATED RABBITS. Geszti, Olga; Hegyi, Gabor. Honvedorvos, 19: 168-76(Apr.-June 1967). (In Hungarian).

In response to the effect of x irradiation with doses that produce death in 25 and 90 per cent of the rabbits, there is a definite difference in the hematological values as well as in the shape of curves registering changes in body weight between animals which are to survive and to succumb. A consequent decrease in the body weight of the animals after the 4th day, a sharp drop in their thrombocyte count around the 7 to 10th day, an absence of regeneration of the erythropoiesis can be looked upon as unfavorable prognostic signs. The chances for survival or death can be estimated with the greatest probability by changes in the gran-

ulocyte count insofar as a granulocytosis surpassing the average normal value 24 hours after the irradiation is indicative of an extremely severe or lethal radiation damage. The extent of granulocytosis is presumably related to the actual radiation sensitivity of the individual. (JPRS)

21579 RADIATION BIOLOGY AND CELL POPULATION KINETICS. Lamerton, L. F. (Inst. of Cancer Research, Surrey, Eng.). Phys. Med. Biol., 13: 1-14(Jan. 1968).

Techniques of cell population kinetics, response of normal tissue, and response of tumors were the chief topics included in the Tenth Douglas Lea Memorial Lecture. It was emphasized that the development of the subject of cell population kinetics has opened up a new range of experimental opportunities in radiobiology. It also leads to a closer integration of radiation studies and biology. Radiation is becoming a powerful tool in the study of biological dynamics at the higher levels of biological organisation. (UK)

21580 DIFFERENTIAL RADIOSENSITIVITY OF THE HEPATIC MELANOCYTES OF AMPHIUMA TRIDACTYLUM. Prasad, Kedar N.; Johnson, Horton A. (Univ. of Colorado, Denver. Brookhaven National Lab., Upton, N. Y.). Radiat. Res., 33: 403-16(1968). (BNL-12119).

X-irradiation of liver segment of Amphiuma showed an inverse correlation between radiosensitivity of the melanocytes and their degree of pigmentation. The presence of polymelanosomes appears to be directly related to the radiosensitivity of the melanocytes. (auth)

21581 EARLY POSTIRRADIATION CHANGES LEADING TO THE LOSS OF NUCLEAR STRUCTURE IN RAT THYMOCYTES. Whitfield, J. F.; Youdale, T.; Perris, A. D. (National Research Council, Ottawa). Exp. Cell Res., 48: 461-72(Nov. 1967). (NRC-9579).

The loss of thymocyte nuclear structure begins 45 to 60 min after γ irradiation. During this cytological latent period there are two distinct phases of response to radiation that combine sequentially to destroy the normal nuclear structure. The damage that develops during the first phase can become fully and irreversibly established in the absence of extracellular phosphate, but further development of damage in the second phase initially requires the presence of an adequate supply of extracellular phosphate. Between 30 and 45 min after irradiation the continued progress of events becomes independent of the extracellular phosphate supply and ten min thereafter it can no longer be blocked by dinitrophenol. The most probable mechanisms underlying these phases are discussed. (auth)

21582 THE PLASMA IODOTYROSINE CONTENT IN EUTHYROID SUBJECTS AND IN PATIENTS WITH GRAVES' DISEASE. Foldes, Janos; Gyertyanfy, Geza; Tamas, Gyula; Gesztesi, Erzsebet; Takacs, Ilona (Medizinische Klinik, Budapest). Nucl.-Med., 6: 400-10(Dec. 30, 1967). (In German).

The iodotyrosine concentration in the plasma of euthyroid subjects and of patients with Graves' disease was studied by means of gel filtration and ion exchange. In the plasma of euthyroid subjects iodotyrosine could be found in only very small amounts or not at all. In several hyperthyroid patients a substantial amount of mono- and diiodotyrosine was detected that was unrelated to the weight of the thyroid gland. The iodotyrosine levels in the plasma of hyperthyroid patients was compared after administration of ^{125}I that results in smaller radiation damage, and after ^{131}I therapy. In most cases the plasma iodotyrosine concentration was increased after ^{131}I therapy that is attributed to radiation damage to the thyroid. Thyroglobulin was found in plasma only in few patients and at low concentration. The iodotyrosine level in the plasma was unrelated to its thyroglobulin content. (auth)

21583 RADIOSENSITIVITY OF IMMATURE MALE GONADS IN GOLDEN HAMSTER. II. GONOCYTES AND SPERMATOGONIA A. Skowron, S. (Polish Academy of Sciences, Krakow). Folia Biol. (Warsaw), 15: 395-8(1967).

Six-day old hamsters in which spermatocytes only were present in the testes and 12-day old hamsters containing spermatogonia in the testes were x-irradiated. The former group of hamsters was killed at the age of 30 days and the latter at the age of 60 days. The testes were prepared for histological examination. Observations indicated that the spermatocytes were especially radiosensitive, while the spermatogonia exhibited a relatively high degree of radioresistance. (H.L.W.)

21584 ON THE MORPHOGENETIC FUNCTION OF NUCLEI IN THE GOLDFISHxLOACH (CARASSIUS AURATUS AURATUSx-MISGURNUS FOSSILIS) HYBRIDS. Neifakh, A. A.; Radzievskaya, V. V. (Inst. of Developmental Biology, Moscow). Genetika, No. 12, 80-8(Dec. 1967). (In Russian).

While the crosses goldfish x loach give hybrids that develop normally and reach the larval stage, the androgenetic haploid hybrids (produced by the fertilization of irradiated loach eggs with normal goldfish sperm) were incapable of differentiation and their development ceased at the stage of late blastula, similarly to what was shown for "enucleated" embryos (the result of the irradiation of both gametes). The chromosome count in the hybrids showed that a large proportion of chromosomes ($^1/_4$ to $^1/_3$) were eliminated. It was shown by a number of experimental studies of the influence of goldfish chromosomes on the development and survival of irradiated embryos, that the goldfish chromosomes in diploid hybrids play an active morphogenetic role beginning from the early embryonic stages. The arrest of development in androgenetic haploid hybrids can be explained by the loss of a part of the genotype that is necessary for the development, or by the incapability of the goldfish chromosomes to function in the loach cytoplasm in the absence of the loach chromosomes. This problem can be solved by the determination of the messenger-RNA synthesis. (auth)

21585 MICROWAVE RADIATION AND HUMAN TOLERANCE. A REVIEW. Westin, Jerome B. J. Occup. Med.,10: 134-41 (Mar. 1968).

With present technology capable of installing very high-powered radar aboard air- and spacecraft, it is becoming increasingly important to investigate the biologic hazard due to microwave radiation, and set meaningful and realistic limits. It is shown that this hazard is an extremely complex situation, and the variables associated both with the human absorber (including thermal and non-thermal hazard, depth of penetration, standing wave formation, dielectric coefficient of various tissues), and with the generator (pulsed v. cw generation, antenna rotation, near v. far field, etc.) are legion. The need for further and systematic investigation of the problem is underlined, and it is noted that until additional data are forthcoming, the present exposure criterion of 10 mw/cm^2 must be followed. (auth)

21586 URINARY EXCRETION PATTERN OF SEROTONIN AND 5-HYDROXYINDOLE ACETIC ACID IN ULTRAVIOLET INDUCED ERYTHEMA. Veninga, T. S.; de Boer, J. E. (Univ. of Groningen, Netherlands). J. Invest. Dermatol., 50: 1-8(Jan. 1968).

Man exposed to 250 nm ultraviolet irradiation or to sunlight over both sides of their thorax demonstrated a rise in urinary serotonin excretion. In two subjects a pronounced erythemal response to artificial UV was accompanied by a considerable rise of the urinary serotonin level. Six subjects showed a mild erythemal reaction; at the same time a less distinct serotonin increase was observed. Two test subjects did not react by reddening of the skin and simultaneously failed to show a urinary serotonin response. In some cases urinary 5-hydroxyindole acetic acid, the main metabolite of serotonin, also showed a tendency to be increased after UV irradiation and sunburn, although its reaction might be somewhat obscured by the more irregular normal excretion pattern. It appears to be possible that serotonin acts as a mediator substance in the erythemal response, although the occurrence of the amine as a side-product can not be excluded. (auth)

21587 REPAIR OF DAMAGED DNA IN A EUCARYOTIC CELL: TETRAHYMENA PYRIFORMIS. Brunk, C. F.; Hanawalt, P. C. (Stanford Univ., Calif.). Science, 158: 663-4 (Nov. 3, 1967).

Damage induced by ultraviolet light or x rays to the DNA of a eucaryotic organism, Tetrahymena pyriformis, is repaired by a process similar to the repair system present in bacteria. This repair process, which involves defect excision and subsequent resynthesis of the damaged section of DNA, occurs in the dark. Photoreactivation of damage induced by ultraviolet light is also indicated by a reduction in observed repair synthesis. An improved method for detecting repair synthesis is described. Repair synthesis is measured in parental DNA strands isolated from cultures that have undergone normal DNA replication after the repair process. (auth)

21588 SPERMATOGENESIS IN THE DOGS UGOLYOK AND VETEROK AFTER THE KOSMOS-110 SPACEFLIGHT. Fedorova, N. L. Kosm. Biol. Med., 1: 28-31(1967). (In Russian).

Study of the combined effects of ionizing radiation and other spaceflight factors on reproduction is of interest in view of the high radiosensitivity of the gonads. The rather scant data on the effects of spaceflight on mammalian reproduction do not as yet allow conclusions to be drawn; however, the female dog Strelka was subjected to spaceflight and subsequently experienced normal pregnancy, delivery, and lactation of healthy puppies. This article presents data on spermatogenesis in the two males, Ugolyok and Veterok, flown for 22 days on the Cosmos-110 satel-

lite; the results of breeding them to normal females are also given. The study included four healthy male dogs as controls, two of which had undergone the training program for spaceflight. The first study of ejaculate was made 10 days after the spacecraft was brought back to earth; studies were subsequently made at monthly intervals. The ejaculate was studied by standard methods, and criteria included volume, color, sperm concentration, percentage of atypical forms, and sperm activity and motility rated on a five-point scale. A significant increase in the number of atypical spermia was found in the ejaculate of the experimental animals, particularly Veterok; this increase proved to be transitory. The breeding of Ugolyok and Veterok with healthy females resulted in uneventful delivery of normal litters. For the first few months, however, attempts to breed Veterok were not successful. It was noted that the changes observed in the dogs' atypical spermia were not of a pathological nature and that such changes were observed in normal animals when there were long intervals between ejaculations and when the physical environment was altered. Lowered resistance and general weakness of the organism could also be influential factors. In general, spaceflight did not affect the reproductive capacity of the animals and did not result in any abnormalities in the first-generation offspring. (ATD)

21589 RADIATION AND SPACEFLIGHTS. Grigor'ev, Yu. G.; Kovalev, E. E.; Pravetskii, V. N. Kosm. Biol. Med., 1: 3-6(1967). (In Russian).

This editorial-type article discusses spaceflight radiation safety systems, requirements for which have been made more specific as a result of intensive investigations such as those conducted on the "Kosmos-110" satellite. Radiation safety systems must be integrated into spacecraft design and must be tailored to: (1) the great variety of ionizing radiation sources and radiation conditions met in space; (2) limitations of on-board resources; (3) the requirement for maximum (i.e., absolute) reliability. Functions will be divided between on-board and terrestrial elements of the system. Major tasks of the on-board elements will be: (1) physical and pharmacological shielding of crew and life-support systems; (2) dosimetric monitoring of radiation levels in all parts of the craft and of the doses absorbed by all crew members and ship components; (3) usable forecasts of radiation conditions along a given trajectory, during EVA, and on the surface of other planets. Major tasks of the terrestrial elements of radiation safety systems will be: (1) collection of information about actual radiation conditions in space from the spacecraft and other artificial Earth satellites; (2) observation of astrophysical and geophysical phenomenon preceding or accompanying chromospheric flares; (3) analysis of the cumulative dose on board the spacecraft; (4) comparison of on-board radiation conditions with permissible norms, and the making of medical-hygiene decisions. One of the largest launch-weight penalties cutting into payload is radiation shielding. This weight penalty may be reduced by further study of the precise characteristics and biological effectiveness of the actual radiation encountered on a specific flight, and tailoring the shielding to be carried to meet the safety requirements of that particular flight. One of the objectives of the "Kosmos-110" flight was to determine the attenuation of cosmic radiation by various thicknesses of shielding material and by the spacecraft hull, and the types of secondary particles formed in the shielding material. The uneven distribution of shielding materials means that numerous sensors must be used in order to monitor the nonuniform radiation conditions obtained inside the vessel. Primary data processing must be performed on board to furnish current information about irradiation of various parts of the body, the RBE of various radiation components (based on tissue LET), effective dose, and recovery characteristics. The on-board system should signal the cosmonauts when it is time to take antiradiation countermeasures (taking shelter in the shielding tank, ingesting a dose of antiradiation drugs, etc.). Radioprotective drugs must satisfy the following requirements: they must be effective against low-power radiation doses and various kinds of ionizing radiation; they should have low toxicity, even if repeated after a short time interval; and they should not lower the general reactivity of the organism. (ATD)

21590 DEPRESSION OF LEUKOPOIESIS IN RADIATION THERAPY. Mitrov, G. G.; Zografov, D. G. Rentgenol. Radiol., 6: 9-14(1967).

Changes in the leukocyte count in the peripheral blood of 271 patients subjected to radiation therapy for malignant tumors in various parts of the body were studied. Disturbances in leukopoiesis were exhibited to various degrees as a result of exposure to radiation. The state of the bone marrow in parts of the body not exposed to the direct action of radiation was investigated on 27 patients who developed severe leukopenia. In 19 cases of the 27 investigated, there was no correlation between the state of the bone marrow and the lowered leukocyte count in the peripheral blood. The leukopenia in these cases could be ascribed to a reduction of the lifespan of leukocytes in the peripheral blood. The results showed that a decision in regard to discontinuation of radiation therapy should not be based on data obtained by examining the peripheral blood only, but primarily on the outcome of an investigation of the state of the bone marrow. (JPRS)

21591 PERIPHYTON PRODUCTIVITY AND RADIONUCLIDE ACCUMULATION IN THE COLUMBIA RIVER, WASHINGTON, U. S. A. Cushing, C. E. (Battelle Memorial Inst., Richland, Wash.). Hydrobiologia, 29: 125-39(Mar. 16, 1967).

Best correlations between the four biomass measurements were between dry weight, ash weight, and chlorophyll a. Net production rate varied from 0.005 to 0.070 mg dry weight/cm^2/day and was closely related to chlorophyll a and also to solar energy. The accumulation of ^{32}P and ^{65}Zn was highly related to dry and ash weight and chlorophyll a. Low correlations were found between radioisotope burden of the river. The data suggest that adsorption was the dominant mode of uptake. (auth)

21592 FATE OF THE FROZEN IRRADIATED ALLOGENEIC NERVE GRAFT. Roberts, Theodore S. (Univ. of Utah, Salt Lake City. Veterans Administration Hospital, Salt Lake City). Surg. Forum, 18: 445-7(1967).

A nerve graft was taken from a major branch of the sciatic nerve of one goat and placed in another, between two intercostal nerves in the upper thorax and two similar nerves in the lower thorax. The intercostal nerves were dissected laterally from the ribs for a distance of 5 cm, transected, and the free graft interposed. The suturing of the intercostal nerves and the free graft was accomplished with the plasma clot technique. Irradiation of the nerve, while frozen, was accomplished with a Van de Graaff generator delivering 2 MeV to it. After 18 months no evidence could be obtained that the allografts were capable of neuronal transmission. Evidences of axonal growth were studied by serial sectioning and staining. Axonal proliferation could be seen extending into either end of the graft for a distance of 2 cm. In no case were axons found in the midportion of the graft. (H.L.W.)

21593 EFFECTS OF RADIOACTIVE IODINE INDUCED HYPOTHYROIDISM ON EXPERIMENTAL ATHEROSCLEROSIS. Younger, Rachel K.; Stephenson, Sam E. Jr.; Scott, H. William Jr. (Vanderbilt Univ., Nashville). Surg. Forum, 18: 351-3(1967).

Radioactive iodine induced hypothyroidism clearly enhances the production of experimental hypercholesterolemia and atherosclerosis in mongrel dogs. (auth)

21594 PHYSIOLOGICAL REGENERATION OF THE EPITHELIUM OF THE CORNEA AND INTESTINES EXPOSED TO FRACTIONAL IRRADIATION WITH FISSION NEUTRONS. Mastryukova, V. M.; Strzhizhovskii, A. D. Kosm. Biol. Med., 1: 43-7(Mar.-Apr. 1967). (In Russian).

Results are reported on a study of the mitotic index and content of chromosome aberrations in the epithelial cells of mice exposed to fractional irradiation with fission neutrons at doses of 50, 125, and 500 rad/week. Under these conditions, compensatory processes increasing the tissue resistance to further irradiations developed in the epithelium of the cornea and intestines. This indicated an increase in damage to the cell's genetic structure, affecting mitotic activity. Hence, tissues developed a state of equilibrium having characteristics dependent on the dosage given. (IAA) (TSS)

21595 X-RAY STUDIES AND THE BIOLOGICAL EFFECTS OF IONIZING RADIATION. Olsson, Olle (Univ. Hospital, Lund, Sweden). Radiologe, 7: 109-14(Apr. 1967). (In German).

The author reviews and discusses sources of irradiation in a radiological laboratory and in x ray diagnostic practice, limitations of x irradiation exposure, and the risk of induction of tumors or leukemia by irradiation. The diagnostic value of x rays for improved detection of pulmonary tuberculosis or lung cancer outweighs by far the anticipated increase in leukemia incidence which is usually estimated at less than 1% of the observed spontaneous rate. The possible role of irradiation in increasing the overall genetic risks to human populations is discussed. Other factors that contribute to genetic selection and impairment of genetic patterns are discussed and compared to the possible genetic effects of irradiation. Because of the difficulties of assessing and evaluating these findings an exact conclusion cannot be drawn now. However, the measures that are used by radiologists for close control and supervision of the radiation hazards now apparent indicate responsible use of this valuable diagnostic and therapeutic tool. (BBB)

21596 RADIATION BURDENS AND WOUNDS. ANIMAL EXPERIMENT CONTRIBUTIONS ON THE QUESTION OF COMBINED INJURIES. Langendorff, Hanns; Messerschmidt, Otfried (Univ., Freiburg i. B.). Nippon Igaku Hoshasen Gakkai Zasshi, 26: 289-97(June 1966). (In German).

Open skin wounds occupying 5% of the body surface were inflicted on the backs of mice one hr before or after whole-body x irradiation; radiation mortality was 22% and 32% respectively, while mortality of controls was 26%. When the wound was inflicted one, two, or four days after irradiation, the mortality was 80 to 90%. When inflicted two or three days before irradiation, the mortality was 15%. When mice were irradiated with doses of 100 to 640 R and subjected to open skin wounds two days after irradiation, the effect of the wound on mortality was greatest with the 450 R dose. When a wound was inflicted and reclosed immediately, the radiation mortality was not affected. It is suggested that bacterial infection in the open wounds plays a role in the increased mortality. The time required for healing of a wound was shortest in the non-irradiated group, followed by the group subjected to a wound before irradiation, and longest in the group subjected to a wound after irradiation. In the group subjected to wounds two days after irradiation, histamine showed a slight protective effect, but no protective effect was observed with serotonin, cysteamine, or cysteine. The effects of wounds on radiation mortality were also observed in rats. (NSA of Japan) (TSS)

21597 THOROTRASTOSIS AND MILITARY-SERVICE-CONNECTED DAMAGE. Ziegler, H. K.; Franke, F. (Pathologisches Institut der Krankenanstalten, Bethel, Ger.). Med. Klin. (Munich), 61: 1658-62(Oct. 21, 1966). (In German).

Veterans who were hospitalized for wartime service disorders were observed for symptoms induced by thorotrast. Records were only partially available, but the pathological findings indicated that Th was administered ~20 yr previously. Clinical findings in the patients included marked splenomegaly, myelocytic infiltration of spleen, bone marrow, lymph nodes, liver, oral mucosa, and interstitia of the lungs and kidneys. There were crystalline deposits in spleen and bone marrow, and pigmentation in liver and spleen. In one patient a tumor was found in the right lobe of the liver, with destruction of the right adrenal and the upper poles of the kidneys, multiple metastases in the lymph nodes of the liver hilus, lung hilus, and in both lungs, and pleuritis sarcomatosa. There was histological evidence of reticulothelial sarcoma and hemangioendothelioma. In another patient with liver cirrhosis and leukemia there were multicentric tumor infiltrations with hemangioendotheliomic and reticulosarcomatous structures in the blood and lymph vessels, contracted spleens, with thrombosis of many arteries and total infraction of the organ, and multiple deposits of Th in liver, spleen, lymph nodes, and bone marrow. (BBB)

21598 EFFECT OF PROLONGED ADMINISTRATION OF RADIOACTIVE IRON ON THE ELECTRICAL ACTIVITY OF THE CEREBRAL CORTEX OF RABBITS. Ginsburg, D. A. pp 38-51 of The Toxicology of Radioactive Substances. Vol. 3. Letavet, A. A.; Kurlyandskaya, E. B. (eds.). New York, Pergamon Press, 1967.

Results are reported from an electroencephalographic investigation of rabbits following the oral administration of $^{59}FeCl_3$ in doses of 10 μCi/kg/day. No significant changes in electrical activity of the brain were observed during a 3-month period. Changes in response to rhythmic light stimuli were observed after 3 to 5 weeks. (C.H.)

21599 THE EFFECT OF PROLONGED ^{59}Fe ADMINISTRATION ON HAEMOPOIESIS. Beloborodova, N. L.; Ponomareva, V. L.; Red'kina, E. K. pp 52-60 of The Toxicology of Radioactive Substances. Vol. 3. Letavet, A. A.; Kurlyandskaya, E. B. (eds.). New York, Pergamon Press, 1967.

The effects of the prolonged administration of ^{59}Fe on hematopoiesis were studied in rabbits. The animals were given $^{59}FeCl_3$ in daily doses of 1 μCi/kg or 10 μCi/kg body weight during a 12-month period. Control animals were given similar doses of stable Fe. Samples of bone marrow and blood were examined periodically. In the group of animals that received stable Fe, an increase in erythrocyte size and hemoglobin content were observed during the first four months and an increase in erythrocyte cell count was observed after 8 to 10 months. Administration of the small dose of ^{59}Fe caused early stimulation of erythropoiesis and an increase in the number of erythroblast cells and reticulates in the bone marrow. Administration of the larger daily dose of ^{59}Fe caused general impairment of hematopoiesis as demonstrated by changes observed in erythroblastic tissues and an increase in erythrocyte size and hemoglobin content. Depression of lymphopoiesis was observed after the first month and changes in neutrophil nuclei were observed by the end of the year. (C.H.)

21600 THE EFFECT OF PREGNANCY AND PARTURITION ON HAEMOPOIESIS IN RABBITS DURING PROLONGED ^{59}Fe ADMINISTRATION. Beloborodova, N. L.; Ponomareva, V. L.; Red'kina, E. K. pp 85-92 of The Toxicology of Radioactive Substances. Vol. 3. Letavet, A. A.; Kurlyandskaya, E. B. (eds.). New York, Pergamon Press, 1967.

The effects of daily doses of 10 μCi/kg body weight of $^{59}FeCl_3$ for ten months prior to the onset of pregnancy on hematopoiesis were studied in rabbits. Samples of peripheral blood and bone marrow, obtained at various times during pregnancy and up to 10 days after parturition, were examined for morphological changes in the cells. Pregnancy produced marked changes in hematopoiesis in control rabbits but hematopoiesis returned to normal soon after parturition. Functional deficiencies of hematopoietic tissues were more severe in the animals that had received $^{59}FeCl_3$, and recovery after parturition was delayed. Anemia during pregnancy was manifested earlier, persisted longer after parturition, and was accompanied by pathological changes in erythrocytes. The lymphocyte count declined during pregnancy in the experimental animals and a pronounced lymphopenia was observed. (C.H.)

21601 PERIPHERAL BLOOD CHANGES IN WHITE RATS FOLLOWING INTRATRACHEAL INJECTION OF VARIOUS ^{59}Fe COMPOUNDS. Sagaidak, N. D. pp 93-104 of The Toxicology of Radioactive Substances. Vol. 3. Letavet, A. A.; Kurlyandskaya, E. B. (eds.). New York, Pergamon Press, 1967.

Results are reported from a study of changes in the content of cells in the blood of rats following intratracheal injection of ^{59}Fe-labeled insoluble and soluble compounds. Observations were made during a 15-month period after single or triple injections of insoluble $^{59}Fe_2O_3$ powder or injections of various doses of ^{59}Fe-labeled citrate solutions. The blood of all animals was examined prior to administration of ^{59}Fe and monthly examinations were made of hemaglobin content of erythrocytes, cell count, and cell morphology after administration. Administration of soluble ^{59}Fe-labeled citrate in doses ranging from 1.06 μCi/kg to 27.5 μCi/kg body weight caused a slight stimulation of hematopoiesis that was followed by quantitative and qualitative changes in the leukocytes indicating damage to hematopoietic tissues. An increase in erythrocyte count and hemaglobin content remained constant. Administration of single or triple doses of 0.03 μCi/gm body weight of insoluble $^{59}FeO_3$ resulted in slight changes in the peripheral blood. (C.H.)

21602 CHANGES IN CARBOHYDRATE METABOLISM AND THE SERUM PROTEIN FRACTIONS DURING PROLONGED ADMINISTRATION OF ^{59}Fe. Orlyanskaya, R. L. pp 105-13 of The Toxicology of Radioactive Substances. Vol. 3. Letavet, A. A.; Kurlyandskaya, E. B. (eds.). New York, Pergamon Press, 1967.

Changes in the content of protein fractions and sugar in the blood of rabbits were measured following administration of 1 μCi/kg or 10 μCi/kg body weight of ^{59}Fe during a period of nine months. No change was observed in the content of sugar in the blood. No change was observed in the total serum protein content of blood. The larger dose of ^{59}Fe caused a decline in the serum albumin content and an increase in serum globulin content during the sixth month. (C.H.)

21603 THE EFFECT OF PROLONGED INTERNAL ADMINISTRATION OF $^{59}FeCl_3$ ON THE RABBIT ELECTROCARDIOGRAM. Saitanov, A. O. pp 114-29 of The Toxicology of Radioactive Substances. Vol. 3. Letavet, A. A.; Kurlyandskaya, E. B. (eds.). New York, Pergamon Press, 1967.

The effect of administration of daily oral doses of 1 μCi/kg or 10 μCi/kg body weight of $^{59}FeCl_3$ to rabbits on heart function was studied over a two-year period. Electrocardiograms were made periodically and examined for changes in the nervous regulation of the heart. Transitory changes were observed during the first year. A marked effect on bioelectrical processes in the heart was observed during the second year. The effect was more pronounced and appeared earlier in animals receiving the larger dose. (C.H.)

21604 THE EFFECT ON THE HEARTS OF RABBITS OF PROLONGED INTERNAL IRRADIATION WITH SMALL DOSES OF $^{59}FeCl_3$. Saitanov, A. O. pp 130-9 of The Toxicology of Radioactive Substances. Vol. 3. Letavet, A. A.; Kurlyandskaya, E. B. (eds.). New York, Pergamon Press, 1967.

The effect of prolonged internal irradiation of rabbits with small daily doses of $^{59}FeCl_3$ on the nervous mechanisms regulating heart activity was studied using the response of cardiac activity to ammonia inhalation or intravenous injection of adrenalin. Cardiac activity was recorded on film using an electrocardiograph. Alterations in the intensity and duration of the cardiac reflex of the vagus nerve were observed during the first six to twelve months. Changes in cardiac reaction to ammonia or adrenalin occurred earlier and were more pronounced in rabbits receiving a daily dose of 10 μCi/kg of $^{59}FeCl_3$ than in animals receiving a 1 μCi/kg dose. (C.H.)

21605 MORPHOLOGICAL CHANGES IN RATS AFTER INTRATRACHEAL INJECTION OF VARIOUS ^{59}Fe COMPOUNDS.

Sagaidak, N. D. pp 140-57 of The Toxicology of Radioactive Substances. Vol. 3. Letavet, A. A.; Kurlyandskaya, E. B. (eds.). New York, Pergamon Press, 1967.

Results are reported from studies on rats concerning the distribution in tissues and pathological effects of various doses of insoluble ^{59}Fe oxide or soluble ^{59}Fe citrate following intratracheal injection. The β radiation dose received by the lungs was calculated. No evidence of acute radiation injury was observed but animals that received doses of 1.06, 3.36, or 27.5 μCi of ^{59}Fe oxide developed inflammation, abscesses, bronchiectases, and malignant bronchial tumors from 6 to 15 months after injection and their life span was shortened. Injection of 20 μCi of ^{59}Fe citrate resulted in inflammation of the bronchi and sclerotic lesions in the peribronchial tissue. (C.H.)

21606 MORPHOLOGICAL LESIONS IN THE ORGANS OF RABBITS DURING PROLONGED ADMINISTRATION OF ^{59}Fe. Gaidova, E. S. pp 158-72 of The Toxicology of Radioactive Substances. Vol. 3. Letavet, A. A.; Kurlyandskaya, E. B. (eds.). New York, Pergamon Press, 1967.

The pathological effects of daily oral administration of $^{59}FeCl_3$ to rabbits in doses of 1 μCi/kg or 10 μCi/kg body weight were examined over a 2.5-yr period. The development of lesions was directly proportional to the amount of ^{59}Fe received. Prolonged administration of ^{59}Fe lowered body resistance to infections and caused general adiposis and varying degrees of inflammation, necrosis, and sclerosis in hematopoietic tissues, spleen, lungs, gastro-intestinal tract, liver, kidneys, and gonads. (C.H.)

21607 INVESTIGATION OF THE RADIORESISTANCE OF PARAMECIUM CAUDATUM DURING RECONSTRUCTION OF THE NUCLEAR APPARATUS. Zinov'eva, E. G. pp 28-35 of Vliyanie Ioniziruyushchikh Izluchenii na Nasledstvennost'. Dubinin, N. P. (ed.). Moscow, Izdatel'stvo Nauka, 1966. (In Russian).

An investigation of Paramecium caudatum revealed that during their life cycle they have a state of low resistance to x rays. The loss of radioresistance was found to be related to the process of reconstruction of the nuclear apparatus. At the state of reorganization of the nucleus, loss of radioresistance was observed after resorption of fragments of the old macronucleus. Systematic x irradiation of paramecia induced in them a more frequent reorganization of the macronucleus than was normal. In each individual paramecium irradiation caused an increased frequency of reorganization of the macronucleus but the distribution in the culture of the number of paramecia simultaneously entering into reorganization was a statistical event. Thus, fluctuations in the survival rate of paramecium which were noted under irradiation are related to the fluctuation of the number of paramecia undergoing, at a given instant, any type of reorganization of the nuclear apparatus. (ATD)

21608 THE INFLUENCE OF TEMPERATURE VARIATION IN THE MEDIUM ON THE DNA CONTENT OF PARAMECIA AFTER IONIZING IRRADIATION. Kovaleva, N. E.; Selivanova, G. V. (Inst. of Cytology, Leningrad). pp 36-45 of Vliyanie Ioniziruyushchikh Izluchenii na Nasledstvennost'. Dubinin, N. P. (ed.). Moscow, Izdatel'stvo Nauka, 1966. (In Russian).

Clones of Paramecium caudatum adapted to 22° and 4°C and fed cultures of yeast Saccharomyces ellipsoideus and bacteria Bacillus subtilis received an x ray dose of 75 kR at 37.5 kR/minute. Those adapted to 22°C were then transferred to 4°C and vice versa. All were fixed 3, 6, 10, 20, and 30 days after irradiation and the DNA in the macronucleus was determined. Shifts in the DNA content connected with the rate of division and variation in the intensity of DNA synthesis were detected. In adaptation to low temperatures the DNA content increased, indicating an increase in the degree of ploidy. In adaptation to higher temperatures the DNA content decreased. (JPRS)

21609 REMOTE AFTEREFFECTS IN IRRADIATED MONKEYS (MACACA MULATTA). Arsen'eva, M. A.; Bakulina, E. D.; Movchan, O. T.; Lander, E. Ya.; Kosichenko, L. P.; Kuksova, M. I. pp 93-108 of Vliyanie Ioniziruyushchikh Izluchenii na Nasledstvennost'. Dubinin, N. P. (ed.). Moscow, Izdatel'stvo Nauka, 1966. (In Russian).

Cytological and histological analyses of the testes and bone marrow of monkeys (Macaca mulatta) from 11 months to 7 years after γ irradiation in doses of 300 to 600 R showed the presence of definite latent effects of ionizing radiation. The dependence of the process of destruction of the testes and of the recovery process of spermatogenesis on radiation dose and age of the animal was determined. Irradiation at a young age led to a more pronounced lesion of the germ epithelium and affected the recovery process. These disturbances in the recovery process indicate damage to the primary spermatogonia which were retained for a number of years after irradiation. Morphological and cytogenetic analyses of the bone marrow of irradiated monkeys demonstrated a number of severe changes indicating hematopoietic disorders. A real increase in the frequency of nuclear disturbances in bone marrow cells of monkeys that had suffered radiation sickness 3 to 5 years earlier was demonstrated. The nature of the chromosome bridges and fragments in the bone marrow cells of monkeys that were observed a number of years after irradiation is discussed. (ATD)

21610 THE RADIOSENSITIVITY OF TYPE-A SPERMATOGONIA IN MACACA MULATTA. Bakulina, E. D.; Lander, E. Ya. (Inst. of Biological Physics, Moscow). pp 109-14 of Vliyanie Ioniziruyushchikh Izluchenii na Nasledstvennost'. Dubinin, N. P. (ed.). Moscow, Izdatel'stvo Nauka, 1966. (In Russian).

Male monkeys (Macaca mulatta) were x-irradiated locally with a dose of 100 R at 14.7 R/minute and castrated at various times from 15 hrs to 17 days, 15 hrs later. Sections of testes were fixed and stained and the spermatogonia of types A_1 and A_2 and Sertoli's cells were counted. It was found that irradiation killed the A_1 and A_2 spermatogonia and suppressed their mitotic activity. The dose administered caused potential injury to the cells of resting A_1 spermatogonia, so that in subsequent divisions they did not form viable A_2 spermatogonia. The A_2 type was much more radiosensitive than the A_1. (JPRS)

21611 THE EFFECTS OF X IRRADIATION ON THE NUMBERS AND VIABILITY OF EXPERIMENTAL POPULATIONS OF DROSOPHILA MELANOGASTER. Bileva, D. S. (Inst. of Cytology and Genetics, Novosibirsk, USSR). pp 177-87 of Vliyanie Ioniziruyushchikh Izluchenii na Nasledstvennost'. Dubinin, N. P. (ed.). Moscow, Izdatel'stvo Nauka, 1966. (In Russian).

Drosophila melanogaster was irradiated with 500, 1500, 3000, and 5000 R x radiation and the population dynamics investigated. During the first 17 days, the decrease in numbers and viability varied directly with the dose. From the 27th to the 45th day, flies irradiated with 500 and 1500 R outdistanced the controls in numbers. At that stage, viability was equalized in the irradiated and unirradiated populations in the second and third generations. From the 55th to 144th day, numerical equilibrium was established in all populations; from the 170th to the 335th day the populations again differed in numbers, evidently due to temperature variations. On the 434th day the experimental population did not differ from the control in viability. (JPRS)

21612 VARIATIONS IN RADIORESISTANCE OF RATS DURING THE PERIOD OF GROWTH. Reincke, Ursula; Mellmann, Juergen; Goldmann, Ehrentraud (Univ., Freiburg i. B.). Int. J. Radiat Biol., 13: 137-46(1967).

Values for $LD_{50(30)}$ were estimated in about 7000 Wistar rats of various ages from the late fetal period up to 10 months old. The rats were exposed to bilateral 200 kV whole-body x irradiation. The dose variations throughout the whole volume of the animals did not exceed ±4 per cent. The tissue dose in rads was determined by special measurements. The LD_{50} values demonstrated an increasing radioresistance in fetuses from the age of gestation day 17 to one day before birth. Immediately after birth the radioresistance was less than one day before. Increasing radioresistance was seen again during the first part of the suckling period and after weaning. During the second part of the suckling period no change or radioresistance occurred. (auth)

21613 THRESHOLD OF ERYTHEMA SKIN REACTION TO UV IRRADIATION IN NEUROSES. Grunner, O. Activ. Nerv. Super., 8: 219(June 1966).

Erythema threshold of uv irradiation was determined by 228 examinations conducted on 131 patients. A three minute dose was considered to be normal physiological value. Appearance of erythema after 5 minutes was considered to indicate hyporeactivity and erythema appearing in the first minute of irradiation indicated hyperreactivity. If no reaction was observed after 5 minutes, skin was considered to be areactive. It was determined that the number of abnormal values of dose response increased with the intensity of neurotic symptoms. The relationship between uv irradiation tolerance and neuroses was not quite clear. This indicates a certain independence of processes on skin periphery. Constitutional hormonal and trophic influences also affected skin reactivity. (ATD)

21614 LEVELS OF TOTAL AND FREE SULFAMETHOXIDE IN THE BLOOD OF RATS AFTER AN IRRADIATION DOSE OF 600 R. Stranskii, Z.; Vojtkova, V.; Grossmann, V.; Horackova, O.; Randova, Z. (Charles Univ., Hradec Kralove, Czech.). Cesk. Fysiol., 16: 147(Mar. 1967). (In Czech).

Levels of free sulfonamides were too low to be determined. In the first phase of irradiation sickness disturbances of resorption occur; therefore the amount and method of administration of drugs under these circumstances must be selected very carefully. (JPRS)

21615 CHANGES IN THE INFLUENCE OF MORPHINE ON BREATHING OF RATS SUFFERING FROM ACUTE IRRADIATION SICKNESS. Cenkova, V.; Kvetina, J. (Charles Univ., Prague). Cesk. Fysiol., 16: 148-9(Mar. 1967). (In Czech).

The main toxic effect of morphine, that is its effect on the breathing center, was investigated in anesthetized rats between the 3rd and 6th days of acute radiation sickness following a dose of 600 R. After an intravenous administration the morphine effect was less distinctive in irradiated than in healthy rats. (JPRS)

21616 ENHANCEMENT OF PULMONARY METASTASES BY X-IRRADIATION IN RATS BEARING MAMMARY CANCER. Dao, Thomas L.; Yogo, Hiroshi (Roswell Park Memorial Inst., Buffalo). Cancer, 20: 2020-5(Nov. 1967).

Whether x radiation increases the incidence of pulmonary metastases in rats bearing carcinogen-induced mammary cancers was investigated. The experimental data show that local x radiation prior to inoculation of a suspension of mammary tumor cells significantly increased the incidence of pulmonary metastases in the irradiated lungs only. If the irradiation is administered after tumor cell inoculation, the incidence of pulmonary metastasis in the irradiated lungs is not significantly different from the control groups. Whole-body irradiation does not seem to have an effect on pulmonary metastases. The results suggest that increase in incidence of pulmonary metastasis is caused by a local effect of irradiation on the pulmonary tissue and is not an effect of general depression of host-immune mechanisms. The exact mechanism by which irradiation enhances pulmonary metastases is not entirely clear. (auth)

21617 BARRIER FUNCTION OF LYMPH NODE TO TUMOR CELLS AND ERYTHROCYTES. II. EFFECT OF X-RAY, INFLAMMATION, SENSITIZATION, AND TUMOR GROWTH. Fisher, Bernard; Fisher, Edwin R. (Univ. of Pittsburgh). Cancer, 20: 1914-19(Nov. 1967).

The present study was carried out to evaluate the effects of alteration of nodes upon their filtering capacity for tumor cells and erythrocytes. Local irradiation and inflammation, but not diphtheria-typhoid-pertussis (DTP) sensitization, significantly reduced the barrier function of nodes to erythrocytes. These modalities failed to influence the deficient barrier function of lymph nodes to tumor cell dissemination. The results also reemphasize previous conclusions that information in this regard obtained from the study of erythrocytes is not applicable to tumor cells. Properties of the tumor cells per se, rather than biological and mechanical functions of the lymph nodes appear most significant concerning the fate of such cells in these structures. The failure of either local or distant tumor growth to influence the histologic appearance or filtering capacity of lymph nodes for tumor cells suggests a lack of biological responsiveness of such structures to tumor. (auth)

21618 EFFECT OF IONIZING IRRADIATION ON NORMAL LYMPHATIC VESSELS AND LYMPH NODES. Sherman, Joseph O.; O'Brien, Paul H. (Northwestern Univ., Chicago). Cancer, 20: 1851-8(Nov. 1967).

Forty dogs were divided into five groups: (A) control, (B) 1000 rads, (C) 2400 rads, (D) 3000 rads, and (E) 3600 rads. The medical aspect of one pelvic limb was irradiated through a port measuring 12 × 8 cm. Prior to irradiation and at intervals after, the pelvic limb lymphatics and popliteal lymph node were visualized by an indirect technique of lymphangiography. The afferent and efferent lymphatic vessels in the control and treated animals remained essentially unchanged except in four animals. These four animals, one in the 2400 rad group and three in the 3600 rad group, exhibited rupture of the afferent lymphatic vessels at the junction of irradiated and nonirradiated tissues several months after treatment. All treated animals showed a marked permanent decrease in size of lymph nodes several months after treatment. There was no evidence of lymphatic obstruction in any group. The authors conclude that ionizing irradiation appears to have little effect on lymphatic vessels. As reported previously, the lymph node undergoes fibrosis without obstruction. (auth)

21619 COMPARATIVE RESPONSES OF TWO PROTOZOA TO TWO TYPES OF RADIATION. Hodson, S. A. (Univ. of East Anglia, Norwich, Eng.). Experientia, 24: 59(Jan. 15, 1968).

Two closely related species of protozoans, Actinophrys sol and Actinosphaerium nucleofilum, were treated with γ and uv radiation. Results are shown graphically. The survival curve was the same for both species, indicating that any particular radiation acts in the same manner on both species. However, whereas Actinosphaerium nucleofilum was six times as resistant to uv radiation as Actinophrys sol, it was only two and one-half times as resistant to ionizing radiation. (H.L.W.)

21620 POTENTIATION OF RADIATION EFFECT ON FEET OF MICE AFTER PROLONGED APPLICATION OF A TOURNIQUET. Crile, George Jr.; Rodriguez-Antunez, Antonio (Cleveland Clinic Foundation). Acta Radiol., Ther., Phys., Biol., 6: 378-84(Oct. 1967).

The severity of injuries of the feet induced by x radiation were increased by the application of tourniquets to legs of mice. The time between radiation exposure and appearance of radiation reactions was shortened when a tourniquet was applied for four hours immediately before, during, or immediately after, irradiation. When the time between occlusion and irradiation was longer than one day, much of the effect of occlusion was lost, implying a synergistic rather than additive relationship. Inflammatory agents did not increase the effects of radiation. (auth)

21621 PATHOLOGICAL FRACTURE OF THE FEMORAL NECK SECONDARY TO LATE IRRADIATION NECROSIS. Lelek, Imre; Altorjay, Istvan (Medical Univ. of Szeged). Magy. Traumatol. Orthop. Helyreallito Sebesz., 10: 136-42(1967). (In Hungarian).

The late osteoradionecrosis of the femoral neck is considered to be analogous to aseptic necrosis. Similar to congenital dysplasis, the radiation damaged bone tissue has a diminished resistance. Walking or increased use represent microtraumas or more for the femoral neck considering that, during walking, a 4.5 fold body weight is supported by the femoral head. Two observed cases are reported in which late irradiation necrosis of the femoral neck was manifested by pathological fracture. The total dose of irradiation received and the different length of latency periods indicate that the use of the joint may play a definite role in the development of late necrosis or pathological fracture. From the aspect of bone regeneration, i.e., healing of the fracture, the total dose of irradiation given was the more important factor. (ATD)

21622 ENZYMICALLY ACTIVE AND INACTIVE MELANOCYTE POPULATIONS AND ULTRAVIOLET IRRADIATION: COMBINED DOPA-PREMELANIN REACTION AND ELECTRON MICROSCOPY. Mishima, Yutaka; Widlan, Sheldon (Wayne State Univ., Detroit). J. Invest. Dermatol., 49: 273-81(Sept. 1967).

Skin of Caucasian male volunteers was exposed to uv irradiation from a hot quartz lamp having a wavelength of 2400 to 3200 Å. The radiation used was in the range of 2800 to 3200 Å. The time of exposure was 60 to 120 sec, the minimal individual erythema dose. A substantial increase in melanocyte population after uv irradiation and α-methyldopa administration was demonstrated. The ammoniated silver nitrate reaction for premelanin and the combined dopa-premelanin reaction, as well as the dopa reaction, were used. The evidence opposed the current theory that the increase in melanocyte population after uv irradiation is due entirely to the activation of pre-existing enzymically inactive melanocytes. (BBB)

21623 DISTURBANCES OF THE ENDOCRINE SYSTEM BY CHRONIC ACTION OF A ULTRA-HIGH-FREQUENCY FIELD. Kolesnik, F. A.; Malyshev, V. M.; Murashov, B. F. Voenno-Med. Zh., No. 7, 39-41(1967). (In Russian).

The functional state of the thyroid gland and of the hypophyseal-adrenal cortex system of persons chronically subjected to a super-high-frequency field of light intensity (below 10 microwatt/cm^2) was studied. Although the patients had no accompanying illnesses, they showed functional disturbances of the nervous and circulatory systems and unstable peripheral blood indices. There was no enlargement of the thyroid gland. In some of the cases, basal metabolism and thyroid function (as determined by radioactive iodine) were increased; in others there was no noticeable effect. Examination of the 17-hydroxycorticosteroid level in blood plasma and urine, and of the ketosteroid level in urine showed that these levels were lower in comparison with controls, indicating that the functional activity of the hypophyseal-adrenal cortex system was lowered. Although lowering of blood sugar was not retarded, the hypoglycemic phase was observed in a large number of the patients. Thus biochemical and clinical studies indicated that chronic action of microwaves resulted in deficiency in the function of the hypophyseal-adrenal cortex system. Treatment with ACTH evoked very definite response reactions, indicating that the relative insufficiency of the hypophyseal-adrenal cortex system was not caused by exhaustion of the suprarenal glands. Change in the hypophyseal function was attributed to disruptions by the chronic action of microwaves in the higher control centers of the nervous system. (ATD)

21624 ^{59}Fe AND ^{51}Cr STUDIES OF THE EFFECT OF PARTIAL-BODY X-IRRADIATION ON ERYTHROPOIESIS IN BEAGLES. Penikas, Vincent Thomas. Rochester, N. Y., Univ. of Rochester, 1966. 254p.

Thesis.

Beagle dogs that received partial-body exposures of 1000 kVp x rays developed alterations in erythropoietic activity that were

studied using ^{59}Fe and ^{51}Cr as tracers. Three groups of dogs were exposed to 1700 R to the upper-body, one group to 400 R to the lower-body, and a sham-irradiated group was used as a control. In an attempt to determine the degree of erythropoietic activity in the irradiated bone marrow during the period of rapid recovery after an upper-body exposure to 1700 R, two groups received an additional exposure of 400 R to either the upper or lower-body 14 days after initial 1700 R exposure. Ferrokinetic data among the various groups were analyzed and compared. In normal dogs the plasma iron concentration was quite variable and influenced the plasma ^{59}Fe disappearance half-time to the extent that changes in the latter were directly proportional to changes in the former. Analyzing ferrokinetic data according to a single dynamic pool model for the transport of iron from the plasma to the erythron led to an overestimation of hemoglobin synthesis. As a result, the mean erythrocyte life span determined from the hemoglobin renewal rate was approximately 65% of that estimated from ^{51}Cr red cell life span studies. Changes in blood volumes, red cell count, hemoglobin concentration, hematocrit, platelets, reticulocytes, and the appearance of nucleated red cells in the peripheral circulation following partial-body x irradiation are discussed. (Disser. Abstr.) (TSS)

Radiation Effects on Plants

Refer also to abstracts 21146, 21414, 21432, 21445, 21465, 21466, 21470, 21471, 21473–21475, 21486–21495, 21569, and 21579.

21625 (ORO-3400-3) PROGRESS REPORT [ON CHARACTERISTICS OF XYLEM TISSUES EXPOSED TO IONIZING RADIATION], 1967–1968. (West Virginia Univ., Morgantown. Div. of Forestry). Contract AT(40-1)-3400. 69p. Dep. CFSTI.

Secondary xylem tissues of Quercus alba and Liquidombar styraciflua were quantitatively examined for dimensional changes in fibers which were associated with exposure to acute gamma and slow-neutron radiation. In general, no significant dimensional changes were noted in Q. alba during the first year of exposure; however, marked changes in the cell type in the latewood of some specific individuals were noted. This inconsistency may reflect the timing of irradiation with respect to yearly increment development or by a direct effect of irradiation exposure in environmentally stressed trees. A reduction in the length and wall thickness of libriform fibers of Q. alba produced during the second year of radiation exposure was observed. In L. styraciflua, a decrease in fiber tracheid length and wall thickness was noted in the 1960 increment in trees exposed in 1956. The length and diameter of the lumina and length of these cells were also affected in 1959. Exposure dose rate had a pronounced effect in Q. alba. No quantitative changes were found to be associated with total accumulated exposures of 3,500 rads and below. These data suggest that the secondary xylem of Q. alba and L. styraciflua is sensitive to irradiation as evidenced by the dimensional changes induced by exposure to acute gamma and slow-neutron radiation; a return to normal fiber production subsequent to sub-lethal irradiation exposures was evident in trees which were not severely stressed; and radiation effects may occur during the first year of exposure, depending on the timing of irradiation with respect to periodic growth. (auth)

21626 ACTIVITIES OF CNEN LABORATORY FOR NUCLEAR ENERGY APPLICATIONS IN AGRICULTURE. Scarascia Mugnozza, Gian Tommaso (CNEN, Rome). Com. Naz. Energ. Nucl., Notiz., 14: 43-53(Jan. 1968). (In Italian).

A review of the activities of C.N.E.N.'s Laboratory for Nuclear Energy Application in Agriculture is presented including its work programs in the field of genetics, cytogenetics and genetic improvement, radiobiology and radiogenetics research and cooperation with Euratom; nuclear technologies in agronomic and vegetable nutrition studies; and nuclear technologies for the protection of agricultural products (radioentomology and radiation preservation of foods). (auth)

21627 RELATION BETWEEN WATER CONTENT AND RADIOSENSITIVITY OF DRIED SEED. Peisker, M. (Akademie der Wissenschaften, Berlin). Naturwissenschaften, 53: 707(Dec. 1966). (In German).

The radiation sensitivity of seeds dried under various conditions was reported. One group of seeds was first brought into equilibrium over 20% H_2SO_4 and then dried over saturated $CaCl_2$ solution down to a water content of 9.3%. In the second group of seeds after drying over the $CaCl_2$ solution the weeds were dried over 60% H_2SO_4 and a water equilibrium content of 5.3% was obtained. The third group after drying over $CaCl_2$ solution was dried over P_2O_5. The seeds were then exposed to x-irradiation and germinated. The radiosensitivity was measured by the mean sprout length after eight days. If the drying is done over the H_2SO_4 solutions, the radiosensitivity after an initial increase in the vicinity of the equilibrium state again decreases. The site of the extreme obtained is dependent on the initial water content. In drying over P_2O_5 only an increase of the radiosensitivity is observed. (J.S.R.)

21628 EFFECT OF DIFFERENT TYPES OF IONIZING RADIATIONS ON THE INITIATION OF CHROMOSOMAL ABERRATIONS IN PEA. IV. THE RELATIVE BIOLOGICAL EFFICIENCY OF FAST NEUTRONS AND ^{60}Co GAMMA RAYS. Akopyan, E. M. (Inst. of Medical Radiology, Obninsk, USSR). Genetika, No. 12, 58-60(Dec. 1967). (In Russian).

Air-dried pea seeds were irradiated by fast neutrons and ^{60}Co gamma-rays at three different dose rates. Dose-effect curves were obtained for fragments and bridges frequencies and for the proportion of aberrant cells. On the basis of these curves the values of relative biological efficiency of fast neutrons were computed depending on the dose-rate values of gamma-irradiation. The material irradiated was fixed in the beginning of the first mitosis. (auth)

21629 INDUCTIONS OF ALBINO MUTANTS IN RICE BY IONIZING RADIATION. Majumdar, B. (Bose Inst., Calcutta). Sci. Cult. (Calcutta), 33: 376-7(Aug. 1967).

Rice seeds were x-irradiated at doses of 25, 50, and 75 KR and treated with 5, 10, and 15 μCi of ^{32}P. The following year the seeds were sown along with unirradiated control seeds. Albino plants developing from three varieties of irradiated and control seeds were counted. There was an increase of albino plants with increasing doses of radiation, and one variety was found to be more sensitive than others. (H.L.W.)

21630 EFFECTS OF X-RAY AND NEUTRON IRRADIATION ON SEEDS OF PHASEOLUS MUNGO L. Jana, M. K. (Indian Inst. of Tech., Kharagpur). Genet. Agr., 18: 617-28(1964).

Out of the 6 doses of x rays (5,000, 10,000, 20,000, 40,000, 60,000 and 80,000) used for irradiating dry seeds of black gram variety T.9, 80,000 R proved to be lethal dose. At a 60,000 R dose, about 46% of the plants survived up to harvest and a maximum number of mutants was recovered. Of the two doses of neutrons, 4×10^{12} np/cm^2 and 8×10^{12} np/cm^2, the latter proved completely lethal. The % of survival up to harvest was about 32 with the former dose. Germination was not affected, at any of the doses used, but sprouting was delayed. The seedling lethality was mainly due to lack of growth of roots, and most of the seedlings died within 20 days. The abnormalities in R_1 generation were mostly observed in the shape, size and color of the first pair of leaves and earlier trifoliate leaves. The height and number of branches mostly diminished. Flowering was delayed by about 10 to 15 days and the flowering period became longer. The fertility was greatly impaired with radiations. The frequency of semi-sterile plants (50% pollen sterile) was max at 60,000 R and at 4×10^{12} np/cm^2 neutrons and min at 5,000 R x rays. The number of fruits produced per plant varied inversely to the dosage. In the R_2 generation various aberrant types were recovered and these could be grouped into chlorophyll deficient, sterile and vital types. Among the mutants showing morphological abnormalities, x irradiation affected mainly the flower and neutrons affected the leaf characters. (Indian Sci. Abstr.)

21631 EFFECT OF UV RAYS ON VARIOUS STAGES OF THE CELL CYCLE OF CHLORELLA. Anikeeva, I. D.; Vaulina, E. N.; Shevchenko, V. A. pp 16-21 of Vliyanie Ioniziruyushchikh Izluchenii na Nasledstvennost'. Dubinin, N. P. (ed.). Moscow, Izdatel'stvo Nauka, 1966. (In Russian).

An investigation carried out on Chlorella vulgaris demonstrated the high sensitivity of various stages of two successive cell cycles and the DNA synthesis period to ultraviolet rays. This study was carried out on visible gene mutations by analysis of whole mutant colonies. The increase in the quantity of whole mutant colonies that was observed during the period of synthesis was difficult to explain if one proceeded from the fact that mitosis followed after each doubling of the quantity of DNA. In this case the predominance of mutant sectors should have been observed, but in actuality they were encountered by an order more rarely than whole mutant colonies, even after three syntheses. This indicated that after synthesis of DNA all genetic material was situated in structures which could be damaged as a whole by one hit. Such a structure was the polytene chromosome. The predominance of isolocus breaks of sister chromatids and the appearance of isochromatid fragments after the synthesis of DNA in this multithread chromosome indicated damage to the whole chromosome. (ATD) (TSS)

21632 INFLUENCE OF VARIOUS DOSES OF ^{60}Co γ-RAYS ON DUCKWEED AND WATER THYME. Timofeeva-Resovskaya, E. A.; Timofeev-Resovskii, N. V. (Inst. of Medical Radiology, Obninsk, USSR). pp 235-7 of Vliyanie Ioniziruyushchikh Izluchenii na Nasledstvennost'. Dubinin, N. P. (ed.). Moscow, Izdatel'stvo Nauka, 1966. (In Russian).

Duckweed (Zemna minor L.) and water thyme (Elodea canadensis Rich) were irradiated with ^{60}Co γ rays in doses of 250, 1,000, 4,000, 16,000 64,000, and 128,000 R in one experiment and in another experiment water thyme was irradiated with 50, 100, 200, 400, 600, 800, and 1000 R. Segments were then placed in lake water and studied for two months. The lethal dose was about 100,000 R. Doses of about 600 R stimulated the growth of stem shoots in the water thyme and a dose of about 400 R stimulated the growth of the plants and an increase of weight. Doses of 250 to 1000 R stimulated the growth of duckweed; at 4000 R growth was the same as for the control, and doses of 16,000 and 64,000 R killed many of the plants. (JPRS)

21633 MUTAGENIC EFFECT OF X RAYS AS A FUNCTION OF THE STATE OF THE TUBER AT THE TIME OF IRRADIATION. Solomko, E. A. (Inst. of Cytology and Genetics, Novosibirsk, USSR). pp 312-17 of Vliyanie Ioniziruyushchikh Izluchenii na Nasledstvennost'. Dubinin, N. P. (ed.). Moscow, Izdatel'stvo Nauka, 1966. (In Russian).

Tubers of the potato variety "Early Rose" (tubers close to sprouting and freshly gathered tubers in deep rest) were x irradiated with doses of four, six, and eight kR. The irradiation stimulated biological processes that disturbed the physiological rest of the tubers; as a result the resting buds began to sprout first. After irradiation with doses of six and eight kR, hereditary changes appeared that involved a spindle shape of the tubers, but some of those phenotypes had a higher starch content than the original form. The greatest changes were obtained in the freshly gathered tubers. (JPRS)

21634 RADIOBIOLOGY AND SPACE INVESTIGATIONS. Kuzin, A. Aviat. Kosmonavt., No. 3, 25-41(1966).

A review of Soviet radiobiological research is presented. Topics included are: the relative biological effects of corpuscular and ionizing radiations; radiation intensity as a function of terrestrial altitude; radiation intensity on the lunar surface (Luna 10); the biological effects of actual and simulated solar flares; the maximum permissible dose of radiation for humans; the effect of corpuscular radiation on cellular and metabolic processes; the radioprotection of humans and animals by means of pharmacological agents and local shielding of unusually radiosensitive organs; the long-term aftereffects of space radiation; the influence of chronic, low-intensity radiation on functions of the central nervous system; cosmonaut radiation prophylaxis and therapy; the problem of individual human radiosensitivity and regenerative capacity; methods of increasing postradiation regeneration; methods of removing the toxic byproducts of radiation damage from the organism; the effects of space radiation on microorganisms (Chlorella) and plants that could be used in life-support systems (the comparative radiosensitivity of higher plants and the stimulating effect of low-intensity, chronic irradiation on plant growth and mutagenesis); the radiation ecology of the interaction between micro- and macroorganisms in a closed environmental system; the immunologic effects of space radiation; and exobiological aspects of radiobiology and radiochemistry (origin of terrestrial life). Of great interest to radiobiologists are the prospects that speceflights of the near future will undoubtedly collect mineral samples and possibly even living materials from other planets possessing unique radiation environments. (ATD)

21635 RADIOBIOLOGICAL STUDIES IN PLANTS. XII. FURTHER STUDIES ON EFFECTS OF X-RAYS ON POLLEN FUNCTIONS. Uematsu, S.; Nishiyama, I. (Kyoto Univ.). Radiat. Bot., 7: 477-80(Dec. 1967).

Mature pollen grains of Lycopersicum pimpinellifolium were irradiated with x-ray exposures of 1 to 10 kR and immediately applied to stigmas of emasculated flowers. The percentage of fruit set was very high and no significant difference was found with regard to range of exposure. The average weight of fruits gradually decreased, however, as x-ray exposure increased. At 8 kR the weight reduction was 50 percent of control. An increased frequency of shrivelled empty seeds indicated severely arrested seed development. Fifty percent reduction of seed formation was estimated to occur at treatments of slightly less than 2 kR. No seeds were obtained in any fruit following irradiation at 9 kR or more. (auth)

21636 RADIOBIOLOGICAL STUDIES IN PLANTS. XIII. EMBRYOGENESIS FOLLOWING X-IRRADIATION OF POLLEN IN LYCOPERSICUM PIMPINELLIFOLIUM. Nishiyama, I.; Uematsu, S. (Kyoto Univ.). Radiat. Bot., 7: 481-9(Dec. 1967).

Mature pollen of Lycopersicum pimpinellifolium was exposed to 3, 6, 10, 50, and 100 kR of x rays immediately before pollination on non-treated stigmas. Pollen tubes from treated pollen grew and penetrated into the embryo-sacs nearly as well as those of the control, excepting those treated with 100 kR. Usually it was found that, with an increase in exposure, there was a corresponding increase of ovules showing such atypical development of the embryo and endosperm as defective double fertilization or exceedingly retarded growth of the embryo and endosperm. Delay of embryo and endosperm growth was usually observed in irradiated samples. The number of cells in the endosperm 72 hr after pollination with pollen of 3, 6, and 10 kR treatments was ~82, 65, and 32 per cent of the control, respectively. Ovules having nearly normal embryonic development 120 hr after pollination occurred at frequencies of 72, 19, and 14 per cent with pollen treated at 3, 6, and 10 kR, respectively. It was further noted that the normally developing ovules might cease their growth later, and subsequently disintegrate. At 50 and 100 kR zygote formation, or growth of the embryo and endosperm, were almost completely inhibited. (auth) (UK)

21637 EFFECTS OF ACUTE GAMMA IRRADIATION IN BARLEY AT DIFFERENT ONTOGENETIC STAGES. Hermelin, Thorsten (Royal Agricultural Coll. of Sweden, Uppsala). Hereditas, 57: 297-302(1967).

The effect of acute γ-irradiation at different ontogenetic stages has for some years been studied in barley, and this brief report summarizes parts of the results obtained. A more detailed account will be presented later. (auth)

21638 SEEDLING RESPONSES OF VIGNA SINENSIS (L.) SAVI TO GAMMA AND NEUTRON SEED IRRADIATION. Constantin, M. J.; Love, J. E. (Univ. of Tennessee, Oak Ridge). Contract AT(40-1)-gen-242. Radiat. Bot., 7: 497-506(Dec. 1967).

Resting seed of Vigna sinensis (L.) were exposed to γ rays or unmoderated fission neutrons, and seedlings were scored 32 days post-planting. Survival was decreased by the higher exposures of γ rays, but was unaffected by the neutron exposures used. Shoot growth, as measured by dry weight of plant parts above the unifoliate leaves, however, decreased linearly with dose of γ rays and neutrons, and the extent of reduction in shoot growth was comparable for both types of radiation. Based on nuclear volume, the predicted D_{50} for dry weight of shoot growth was 68.4 kR, which was twice the observed value of 33.5 kR, for γ rays. The predicted D_{50} for neutrons (2.4 kR) was comparable to the observed D_{50} (2.7 kR). Highly significant correlations were observed for dry weight vs fresh weight of shoot growth and for dry weight of shoot growth vs dry weight of root growth. The RBE of unmoderated fission neutrons, as compared to γ rays, on the basis of dry weight of shoot growth was ~12. Seed irradiation did not alter seedling composition with regard to nitrogen, protein, chlorophyll and percentage dry matter, although growth was reduced severely. Neutron irradiation of seed caused a higher frequency of first and second trifoliate leaves to develop, with one or both lateral leaflets absent, than did γ-irradiation. (auth) (UK)

Radiation Effects on Microorganisms

Refer also to abstracts 21410, 21420, 21428, 21432, 21469, 21473, and 21579.

21639 RADIATION-INDUCED RESISTANCE TO DODINE IN HYPOMYCES. Kappas, A.; Georgopoulos, S. G. (Democritus Nuclear Research Center, Athens). Experientia, 24: 181-2 (Feb. 15, 1968).

The spores of Hypomyces solani were exposed to γ and uv radiation. The resulting mutants were about two times more resistant to the fungicide, dodine, than the corresponding wild strain. (H.L.W.)

21640 INACTIVATION BY UV, X, AND γ RADIATIONS, OF THE INFECTING AND TRANSFORMING CAPACITIES OF POLYOMA VIRUS. Latarjet, R.; Cramer, R.; Montagnier, L. (Institut du Radium, Orsay, France). Virology, 33: 104-11 (Sept. 1967).

Polyoma virus was irradiated with uv and x rays, under indirect effect conditions, and x and γ rays, under direct effect conditions. The uv source was a low pressure Hg vapor lamp, providing radiation at 2537 Å. Direct-effect conditions with 37-KV x rays and ^{60}Co γ rays were obtained by freezing the virus and irradiating it at −76°C. Under direct effect conditions, ionizing radiations inactivate chiefly by producing breaks in the DNA chain. Single breaks are rarely lethal, whereas double breaks are highly lethal. Any double break, regardless of its location, would be expected to be lethal to infectivity and to transformation as well. In contrast, lesions of the DNA bases produced by uv or by the direct effect of ionizing radiations would be lethal for one function only if such lesions were produced within the corresponding genome. The abilities of the irradiated samples to form plaques (infectivity) and to induce cell transformation were determined. It was found that infectivity was about 5 times more sensitive than transformation to uv and to the indirect effect of x rays. However, both functions were equally resistant to the direct effect of ionizing

radiation. These results were intrepreted as indicating that transformation requires only ⅛ of the viral genome involved in plaque formation, and that any double break in the 2-stranded DNA molecule inactivates both functions. (BBB)

Radiosterilization and Radiopreservation

Refer also to abstracts 21127 and 21421.

21641 (RISO-163) CONSUMER SURVEYS IN GREENLAND FOR ACCEPTANCE EVALUATION DURING STORAGE OF POTATOES SPROUT-INHIBITED WITH γ-RAYS OR FUSAREX. Skou, J. P. (Danish Atomic Energy Commission, Risoe. Research Establishment). Sept. 1967. 30p. Dep.

Results of consumer surveys in Greenland concerning advantages and disadvantages of potatoes sprout-inhibited with γ-rays or with the chemical Fusarex (1,2,4,5-tetrachloro-3-nitrobenzene) are reported. The aim was, first, to ask for consumers' opinion on how the irradiated potatoes stand the special, difficult conditions of storage and transport in Greenland as compared with potatoes treated with Fusarex, and secondly, to elucidate the culinary value of potatoes thus treated, throughout the storage period. The answers were given as judgements of the outer and inner appearance, the sprouting, the amount of rotted potatoes, and the taste. The irradiated potatoes had the best outer appearance throughout storage. The inner appearance was generally good after both treatments, but in one survey a certain amount of irradiated potatoes got internal blackening or black spots late in the storage period. There was little or no sprouting in the irradiated potatoes, while those treated with Fusarex sprouted after a shorter or longer storage time depending on the temperature in the storage rooms. In all surveys, a slight, but significant increase in storage rot occurred in potatoes sprout-inhibited with γ-rays. Under special extreme conditions this rot might become rather severe. For a period immediately after treatment a sweeter taste of irradiated potatoes was registered, but seldom to such an extent that the potatoes were found less acceptable. Later the irradiated potatoes sometimes obtained a higher point score than those treated with Fusarex, especially where they were stored at higher temperatures. (Denmark)

21642 PRESERVING FOOD BY RADIATION: SAFE OR UNSAFE. Sci. Cult. (Calcutta), 33: 364-5(Aug. 1967).

Objections to the use of radiation for preservation of food are discussed. In some cases an unpleasant flavor is produced by radiation. Another objection is the high cost of equipment. The association of radiation with harm to human beings causes prejudice against radiopreservation of food, even though many experiments failed to produce evidence that irradiated food is harmful. Experiments with cells of carrots and other plants grown in tissue culture containing irradiated coconut milk showed that cell growth was inhibited. Harmful mutations developed in fruit flies fed on heavily irradiated food. It is pointed out that rats, pigs, mice, and monkeys fed on irradiated food over a period of ten years failed to show any evidence of harmful effects. (H.L.W.)

21643 STERILIZATION IN FOREIGN PHARMACOPEIAS AND IN THE GERMAN PHARMACEUTICAL BOOK. 7th EDITION. Przyborowski, Rudolf (Humboldt Univ., Berlin). Wiss. Z. Humboldt Univ. Berlin, Math.-Naturwiss. Reihe, 16: 205-11(1967). (In German).

Use of ionizing irradiations and uv irradiation for sterilization under aseptic conditions is mentioned in the pharmaceutical handbooks of Poland and Austria, and in the U. S. Pharmacopeia. The British pharmacopeia permits the use of x rays, γ rays, or fast electrons with a minimum dose of 2.5 Mrad for sterilization of powdered substances. These methods are not mentioned in the German pharmacopeia, edition 7. Thus, the use of irradiation sterilization procedures must be evaluated for each particular case, especially for plastic materials. Several factors to be considered here are changes in elasticity of plastics caused by radiation exposure, the danger of secondary radioactivity of drugs, as well as chemical changes in the materials irradiated caused by the highly reactive hydroxethyl radicals from ethylene oxide. Use of gas sterilization may eventually take precedence over sterilization with ionizing irradiation. (BBB)

21644 GAMMA IRRADIATION: THE PRESERVATION OF HIDES AND SKINS, AND THE STERILISATION OF IMPORTED DRY AND DRYSALTED GOATSKINS. Dempsey, M.; Green, G. H.; Moss, J. A. (British Leather Mfgs. Research Association, Egham, Eng.). J. Soc. Leather Trades Chem., 49: 386-96(Oct. 1965).

In order to sterilize calf and lambskins not less than 2.5 MRad were required. Irradiated calfskins, sealed in bags remained satisfactory for three to six months. Lambskins stored for 12 months were less satisfactory, but not so as to result in appreciably poorer quality leather (semi-chrome clothing). Hair may be loosened by irradiation. Shrinkage temperature was lowered, but did not fall further on storage; it was raised nearly to normal by the increased uptake of chrome tan. The chrome calf from irradiated skin felt firmer than the controls, but there was some evidence that it was a little less strong. Evidence is inconclusive regarding the effect on the leather of salting combined with irradiation. Dry and drysalted skins were irradiated with up to 4 MRad gamma radiation (within which disinfection from anthrax is expected) and then stored for up to 12 months before being made into glacé kid. Irradiation lowered the shrinkage temperature of the raw skin and limed pelt, but that of the leather was little different from normal. The finished leather from the skins irradiated with 4 MRad was damaged. While it is not certain whether at 2 MRad some fall in strength was due to irradiation, to variation in raw material or to processing, irradiation at this level is probably tolerable, as the leather from the irradiated skins was of satisfactory strength and feel. No further fall in shrinkage temperature was found after storage of the irradiated skins, and it is probable that storage after irradiation had no further effect on skins or leather. It is also probable that (at the low level of irradiation) variations in processing affected the quality of the leather as much as did the irradiation, and hence changes in processing might be expected to be able to offset irradiation changes. (auth)

METALS, CERAMICS, AND OTHER MATERIALS

Metals and Alloys

21645 (BMI–1826) PROGRESS RELATING TO CIVILIAN APPLICATIONS DURING OCTOBER–DECEMBER 1967. Keller, Donald L. (Battelle Memorial Inst., Columbus, Ohio). Jan. 1, 1968. Contract W-7405-eng-92. 68p. Dep. CFSTI.

A study of mixed UN–PuN fuels is to conducted for uses in thermal reactor applications. Effects involving preparation of materials, property determinations, irradiation studies, and supportive studies are reported. The casting of uranium–plutonium carbonitrides is also being studied. (J.C.W.)

21646 (NP–17284) BIBLIOGRAPHY ON THE HIGH-TEMPERATURE CHEMISTRY AND PHYSICS OF MATERIALS IN THE CONDENSED STATE. Volume 1967, Number 4, October–December 1967. Diamond, J. J. (ed.) (National Bureau of Standards, Washington, D. C. International Union of Pure and Applied Chemistry. Commission on High Temperatures and Refractories). 84p. NBS, Washington, D. C. Free.

A bibliography containing 866 references is presented on: devices for achieving, measuring, and controlling temperatures above 1500°C; properties, at temperatures below 1000°C, of materials which melt above 1500°C; properties, at temperatures above 1000°C, of materials which melt above 1500°C; properties, at temperatures above 1000°C, of materials which melt below 1500°C; phase equilibria; and reactions at temperatures above 1000°C. (R.C.K.)

21647 CONFERENCE ON THE USE OF ZIRCONIUM ALLOYS IN NUCLEAR REACTORS, OCTOBER 20–21, 1966, MARIANSKE LAZNE, CZECHOSLOVAKIA. GENERAL PROCEEDINGS. II. Plzen, Czechoslovakia, Skoda Works, [1966]. 119p. (In Several Languages). (CONF-661059–(Vol.2)).

The second part contains the discussions and summarized conclusions from papers presented at the conference on the use of zirconium alloys in reactors. The discussions touch mainly on the zirconium alloys behavior as reactor material during a long period of time. Data are included on the means for improving the material and metallurgical structure and properties of zirconium alloys in reactor construction. (R.V.J.)

21648 CONFERENCE ON THE USE OF ZIRCONIUM ALLOYS IN NUCLEAR REACTORS, OCTOBER 20–21, 1966, MARIANSKE LAZNE, CZECHOSLOVAKIA. GENERAL PROCEEDINGS. I. Plzen, Czechoslovakia, Skoda Works, [1966]. 359p. (In Several Languages). (CONF-661059–(Vol.1)).

A separate abstract was prepared for each of the 17 papers presented at the conference. (F.S.)

For abstracts of individual papers see: 21656–21665, 21702–21704, 21728–21730, and 22830.

21649 REACTOR MATERIALS. Volume 11, Number 1. Simons, E. M.; Porembka, S. W. Jr.; Keller, D. L. (eds.). One of Four Technical Progress Reviews Published for the Division of Technical Information, USAEC. Columbus, Ohio, Battelle Memorial Inst., Spring 1968. 84p. GPO $0.70.

Research and development progress on materials is presented in four sections. A separate abstract was prepared for each section. (J.R.D.)

For abstracts of individual sections see: 21650, 21651, 21676, and 21749.

21650 FUEL AND FERTILE MATERIALS. Reactor Mater., 11: 1-17(Spring 1968).

A summary and review of research and development on materials such as μ and μ alloys, Pu and Pu alloys, and Th and its alloys is presented. Information is also included concerning development of coated-particle fuels, properties of U and Th oxides, and properties of carbide and nitride fuels. Results of basic studies of radiation effects on metallic and ceramic fuels are reported. 87 references are included. (J.R.D.)

21651 CLADDING AND STRUCTURAL MATERIALS. Reactor Mater., 11: 30-67(Spring 1968).

Results of research are summarized on corrosion of zirconium alloys, stainless steels, nickel base alloys, and refractory metals by gaseous and aqueous media. Information is included from corrosion tests of stainless steel in Na and NaK, cladding materials in Na, refractory metals in Li, graphite in Cs, structural material in Pb–Be eutectics, structural materials in liquid U fuels, and Ta in liquid Sn. Information is also included from tests of corrosion of structural materials by organic coolants and fused salts. Test results are included on radiation effects on Zr, Zr alloys, stainless steel, nickel-base alloys, cobalt-base alloys, and pressure vessel steels. Data are included on the metallurgy of Cr, niobium alloys, tantalum alloys, Mo, Ta, V, Zr, zirconium alloys, stainless steels, nickel alloys, and pressure vessel steels. Research on C diffusion in bcc metals is reported and phase diagrams of nonfuel refractories are included. Comment on concrete and ceramic technology is presented. 140 references are included. (J.R.D.)

Corrosion and Erosion

Refer also to abstract 21766.

21652 (COO–1319-51) A STUDY OF THE MECHANISM OF STRESS CORROSION CRACKING IN THE IRON–NICKEL–CHROMIUM ALLOY SYSTEM. Quarterly Report, June 17–September 16, 1966. Staehler, R. W. (Ohio State Univ. Research Foundation, Columbus). Dec. 9, 1966. Contract AT(11-1)-1319. 52p. Dep. CFSTI.

Stress corrosion cracking experiments are reported for ternary Fe–Cr–Ni alloys exposed to boiling $MgCl_2$ at 154°C. As is well known, increasing the nickel concentration decreases susceptibility. Results show that increasing the chromium above 10% substantially increases the susceptibility to cracking. Studies of 4th components added to an Fe-15 Ni-20 Cr base show that platinum elements greatly accelerate cracking. Results of studies in metallurgical structure are reported in which the internal metallurgical structure is changed by precipitation or martensitic phase transformation. Studies are reported on the effect of potential on cracking rates. Open-circuit potentials have been determined as a function of time for various alloys. Electron metallographic evidence for ledge-poisoned dissolution is presented for an alloy containing phosphorus. Finally, preliminary transmission electron micrographs are shown from studies to determine the process whereby cold work affects cracking results. (auth)

21653 (EURAEC–1947(Pt.1)) A STUDY ON THE STRESS CORROSION OF STAINLESS STEELS IN CHLORIDE SOLUTIONS. Final Report. (Compagnie des Ateliers et Forges de la Loire, Paris (France). Centre de Recherches). Oct. 1967. Contract 033-64-9-TEE-F(RD). 122p. (EUR–3764) Dep. CFSTI.

Work Performed under United States–Euratom Joint Research and Development Program.

Tests were performed on eight grades of stainless steel, four with an austenitic structure and four with an austeno-ferritic structure. Testing devices used for the study are described. Sample preparations are summarized. Tests in boiling concentrated solutions of magnesium chloride to 44% at 153°C, calcium chloride to 62% at 150°C, and sodium chloride (5N) at 107°C were performed. Results are given. Stress corrosion tests in chlorinated water at 150°C were carried out at various pH in low-pressure autoclaves. At 200°C, tests were performed at pH of 2.6, 6.5 and 10. Experimental data are tabulated and results discussed and compared to previous results. (J.C.W.)

21654 (EURAEC–1947(Pt.2)) STUDY OF STRESS CORROSION AND OF GENERAL CORROSION OF STAINLESS STEELS IN DILUTE SOLUTIONS OF CHLORIDES AT 350°C TO 360°C AND IN STEAM AT 500°C. EVOLUTION OF THE MECHANICAL PROPERTIES AND OF THE STRUCTURE AT THESE TEMPERATURES POSSIBILITY OF MAKING USE OF PROTECTION BY SURFACE CHROMIZATION. Final Report. Badart, A.; Demestre, J.; Desestret, A.; Leveque, R.; Poyet, P.; Wagner, G. H. (Compagnie des Ateliers et Forges de la Loire, Paris (France). Centre de Recherches). Oct. 1967. Contract 033-64-9TEE-F (RD). 71p. Dep. CFSTI.

Work Performed under United States–Euratom Joint Research and Development Program.

Tests were performed on eight grades of stainless steels, four with an austenitic structure and four with an austeno-ferritic structure. The influence of molybdenum and/or silicon additions were studied. Silicon steels display a certain tendency to embrittlement, toward 300 to 400°C for austeno-ferritic steels and 500 to 600°C for austenitic steels. The effect of silicon is stronger than that of molybdenum additions which produces also a certain embrittlement in the case of austeno-ferritic steels, toward 350 to 400°C. Silicon improves the mechanical characteristics and the resistance to creep for short times. Molybdenum improves the resistance to creep. The diminishing resistance to creep of silicon steels, over long durations, is probably due to structural transformations making it useful to study these transformations by the technique used in physical metallurgy. (J.C.W.)

21655 (WAPD-TM-517) THE CORROSION AND HYDROGEN ABSORPTION CHARACTERISTICS OF ZIRCONIUM ALLOYS CONTAINING IRON AND CHROMIUM IN HIGH TEMPERATURE WATER AND STEAM. Kass, Stanley (Bettis Atomic Power Lab., Pittsburgh, Pa.). Feb. 1968. Contract AT(11-1)-Gen-14. 61p. Dep. CFSTI.

The corrosion and hydrogen absorption properties of zirconium base alloys containing 0.5 or 1.0% iron, 0.5 or 1% chromium, and 0 or 0.5% tin in high temperature water and steam have been studied. The alloy containing 0.5% iron and 1.0% chromium with or without 0.5% tin exhibits a very low corrosion rate and at the same time very low hydrogen pickup tendencies. For applications at 680°F and below, the corrosion properties of the tin-bearing alloy are superior. For applications above 680°F, the tin-free alloy is superior. (auth)

21656 POSSIBILITIES FOR INFLUENCING THE HYDRIDING OF ZIRCONIUM ALLOYS. Debray, Werner (Siemens Aktiengesellschaft, Zentrale Entwicklung und Forschung, Erlangen, Ger.). pp 95-110 of Conference on the Use of Zirconium Alloys in Nuclear Reactors, October 20–21, 1966, Marianske Lazne, Czechoslovakia. General Proceedings. I. Plzen, Czechoslovakia, Skoda Works, [1966].

See CONF-661059-(Vol.1)).

Investigation of autoclaving treatments confirmed the possibility for lowering the hydrogen pick-up—at least during the pre-transition range—by starting with autoclaving temperatures of about 250 to 300°C. The importance of the holding time at this temperature is discussed. The results also contribute to the manufacturing of the mechanism of hydrogen uptake. (auth)

21657 ORIENTATION OF HYDRIDES IN ZIRCALOY-2 TUBES. Armand, M.; Givord, J. P.; Trolliet, G. (Societe d'Electro-Chimie, d'Electro-Metalurgie et des Acieries Eletriques d'Ugine, Albertville, France). pp 77-94 of Conference on the Use of Zirconium Alloys in Nuclear Reactors, October 20–21, 1966, Marianske Lazne, Czechoslovakia. General Proceedings. I. Plzen, Czechoslovakia, Skoda Works, [1966]. (In French).

See CONF-661059-(Vol.1)).

Absorption of H makes Zircaloy-2 brittle, especially when hydride planes are perpendicular to the stress direction. Hydride orientation was found to be dependent on deformation. Hydride orientation is radial in tubes drawn without broach resulting in zero-equal transverse elongation. The effect of total reduction is discussed along with a way of reduction by drawing and an annealing effect. (tr-auth)

21658 EFFECTS OF RADIATION AND GAS ADMIXTURES IN WATER ON CORROSION OF ZIRCONIUM ALLOYS. Ambartsumyan, R. S.; Myshkin, V. A.; Ageenkova, L. E.; Anisimova, I. A. pp 159-81 of Conference on the Use of Zirconium Alloys in Nuclear Reactors, October 20–21, 1966, Marianske Lazne, Czechoslovakia. General Proceedings. I. Plzen, Czechoslovakia, Skoda Works, [1966]. (In Russian).

See CONF-661059-(Vol.1)).

The oxidation rate of Zr–Nb alloys and Ozhennite alloys in deaerated water at 290°C and 100 atm, irradiated at 1.5×10^{13} n/cm^2 can be 5 to 6 times higher than the unirradiated rate. The admission of a small quantity of air can raise this rate by a coefficient of 2 to 4. The quantity of absorbed H depends on the environment of the experiment. (tr-auth)

21659 EFFECTS OF IMPURITIES AND ALLOYING ELEMENTS ON ZIRCONIUM RESISTANCE IN HIGH-TEMPERATURE WATER. Zaimovskii, A. S.; Nikulina, A. V. (Inst. of Atomic Energy, Moscow). pp 183-95 of Conference on the Use of Zirconium Alloys in Nuclear Reactors, October 20–21, 1966, Marianske Lazne, Czechoslovakia. General Proceedings. I. Plzen, Czechoslovakia, Skoda Works, [1966]. (In Russian).

See CONF-661059-(Vol.1).

The effect of impurities and alloying elements on Zr corrosion in high temperature water and steam was studied. It is possible to neutralize the harmful effect of some impurities by alloying Zr. Alloying elements change the reaction of Zr with H. Ni increases H absorption while Fe and Nb lower it. (tr-auth)

21660 CORROSION OF ZIRCONIUM AND ITS ALLOYS. Mrkous, Pavel; Filip, Radislav (Skoda Nuclear Power Plant Div., Plzen, Czechoslovakia). pp 215-32 of Conference on the Use of Zirconium Alloys in Nuclear Reactors, October 20–21, 1966, Marianske Lazne, Czechoslovakia. General Proceedings. I. Plzen, Czechoslovakia, Skoda Works, [1966].

See CONF-661059-(Vol.1).

Corrosion of zirconium and its alloys in nuclear reactors are discussed. Non-alloyed Zr of high purity has good corrosion resistance in pressurized water, steam, and CO_2 at 300 to 400°C. The effects of heat treatment, and alloying elements are described. The growth and kinetics of zirconium oxides, mechanisms of corrosion, increased corrosion resistance of Nb–Zr alloys with the addition of Cu, hydrogen pickup, and the effect of H on O on the plasticity of zirconium alloys are related. (F.S.)

21661 THE CORROSION OF ZIRCALOY-2 UNDER RADIATION IN HIGH-PRESSURE WATER. Asher, R. C.; Davies, D.; Hall, A.; Kirstein, T. B. A.; White, P. J. (Atomic Energy Research Establishment, Harwell, Eng.). pp 233-50 of Conference on the Use of Zirconium Alloys in Nuclear Reactors, October 20–21, 1966, Marianske Lazne, Czechoslovakia. General Proceedings. I. Plzen, Czechoslovakia, Skoda Works, [1966].

See CONF-661059-(Vol.1).

Results of Zircaloy-2 corrosion experiments in the Pluto Reactor are discussed. The Zircaloy-2 was in an autoclave with "static" water in a fast neutron field of 4×10^{13} n/cm^2/sec^2 and γ intensity of 10^8 to 10^9 R/hr. A comparison with out of pile corrosion rates is made. When the experiment was performed at 340°C, the enhancement of the corrosion rate was almost threefold. Results are discussed and compared with results obtained at this temperature in steam. (auth)

21662 EFFECTS OF CARBON DIOXIDE ON THE CORROSION RATE OF ZIRCONIUM AND Zr/CuMO/ ALLOYS UNDER WORKING CONDITIONS. Bren, Josef; Vrtilkova, Vera. pp 251-70 of Conference on the Use of Zirconium Alloys in Nuclear Reactors, October 20–21, 1966, Marianske Lazne, Czechoslovakia. General Proceedings. I. Plzen, Czechoslovakia, Skoda Works, [1966]. (In Czech).

See CONF-661059-(Vol.1).

Corrosion rate comparisons of various zirconium alloys in dried and wet CO_2 at atmospheric pressure and 500 to 600°C were carried out. The corrosion rate in wet CO_2 was found to be 1 to 3 times higher, than in dried CO_2. Dispersity and volume of corrosion product, the effects of O, N, H, a change of mechanical properties, and microhardness as a result of corrosion are discussed. (auth)

21663 A STUDY OF ZIRCALOY TYPE ALLOYS INFLUENCE OF IMPURITIES ON ZIRCALOY-2 WATER CORROSION AND MECHANICAL PROPERTIES. Delafosse, J.; Poeydomenge, P. (CEN, Saclay, France). pp 271-318 of Conference on the Use of Zirconium Alloys in Nuclear Reactors, October 20–21, 1966, Marianske Lazne, Czechoslovakia. General Proceedings. I. Plzen, Czechoslovakia, Skoda Works, [1966].

See CONF-661059-(Vol.1).

Zircaloy-2 is a stable material for use in high temperature water. Impurities that most affect its mechanical properties are nitrogen and oxygen. Impurities, that affect its corrosion resistance are nitrogen, and to a small extent aluminum. The mixed corrosion test is excellent for detection of nitriding and is equivalent to the vapor test used for detection of other impurity pollution. (auth)

21664 RADIATION EFFECTS ON THE CORROSION OF ZIRCALOY-2 IN AQUEOUS SOLUTION AT ELEVATED TEMPERATURE. TESTS OF Zr CORROSION IN SUPERHEATED STEAM. Blanchet, J.; Coriou, H.; Grall, L.; Mouhot, R.; Pelras, M. (CEN de Saclay, Gif-sur-Yvette, France). pp 319-43 of Conference on the Use of Zirconium Alloys in Nuclear Reactors, October 20–21, 1966, Marianske Lazne, Czechoslovakia. General Proceedings. I. Plzen, Czechoslovakia, Skoda Works, [1966]. (In French).

See CONF-661059-(Vol.1)).

Corrosion tests of either in-pile or out-of-pile specimens were carried out at 350°C. Adherent oxide layers, deuteride precipitates, and the effect of the purity of zirconium were checked. Corrosion tests in steam at 500°C and 105 kg/mm^2 of various Zr alloys—1% Cr, 2% Cr, 2% Fe, 1% Fe + 1% Cu—demonstrated the advantage of the last composition. (tr-auth)

21665 USE OF ELECTROCHEMICAL POLARIZATION IN REMOTE MEASUREMENT OF CORROSION RATE OF Zr–Nb 2.5 PERCENT IN AQUEOUS SOLUTIONS OF Hf + HNO_3 + H_2SO_4 ACIDS. Beran, Jaroslav; Krausova, Marie; Sulc, Josef (Skoda Nuclear Power Plant Div., Plzen, Czechoslovakia). pp 345-59 of Conference on the Use of Zirconium Alloys in Nuclear Reactors, October 20–21, 1966, Marianske Lazne, Czechoslovakia. General Proceedings. I. Plzen, Czechoslovakia, Skoda Works, [1966]. (In Czech).

See CONF-661059-(Vol.1).

An electrochemical remote-measurement-method of the momentary corrosion rate of zirconium alloy ZrNb-2.5 by aqueous solutions of HF + HNO_3 + H_2SO_4, based on determining the slope of the initial linear region of the galvanostatic cathodic polarisation curve is described. By comparing the results of electrochemical measurements with those obtained by conventional weight-loss measurements a calibrating curve was prepared. (tr-auth)

21666 LEED STUDIES, ADSORPTION OF CARBON MONOXIDE ON THE TUNGSTEN (112) FACE. Chang, Chuan C. (Bell Telephone Labs., Murray Hill, N. J.). J. Electrochem. Soc., 115: 354-8 (Apr. 1968).

Carbon monoxide adsorbs on the clean tungsten (112) face with an initial sticking probability of >0.9 at room temperature and desorbs with heat in three stages, the W(112)-α, -β_1, and -β_2 at 400, 1000, and 1200°K with about 5×10^{14} molecules/cm^2 in each state at maximum coverage. Room temperature adsorption is nondissociative and almost random. Heating a CO covered surface produces well defined C (6×4), P (2×4) and "complex" structures. The α-CO does not contribute directly to any diffraction pattern. The β_1 is associated with the P (2×1) and C (2×4) structures, and an irreversible temperature activated conversion at about 1000°K produces β_2 molecules; these are responsible for the C (6×4) and complex structures. Experiments with (112) substrates containing adsorbed oxygen show that CO does not react to produce CO_2, that CO does not adsorb onto an adsorbed oxygen atom and that in the presence of oxygen not all exposed tungsten atoms adsorb CO. The (112) surface is composed of two exposed (112) planes, and by covering only the second layer tungsten atoms with oxygen, it was found that CO adsorbs on the topmost layer as well as on the second layer. Molecules adsorbed on the top layer desorb as β_1 and the maximum number of β_2 molecules on the surface was proportional to the number of second layer tungsten atoms not covered by oxygen. (auth)

21667 INFLUENCE OF THIN NOBLE METAL FILMS ON ZIRCONIUM OXIDATION. Fiegna, A.; Weisgerber, P. (EURATOM-CCR, Ispra, Italy). J. Electrochem. Soc., 115: 369-71 (Apr. 1968).

In order to find suitable contacts for measurement of electric properties of zirconium oxide on zirconium metal during oxide-forming reactions, the influence of metallic deposits on the reaction rate had to be investigated. Samples of Zirconium were coated with Pt, Au, Ag, Pd, or Rh and weight gains in oxygen were plotted. These coatings at 100 to 300 Å thickness did not block the surface from reactions with oxygen and water vapor. A catalytic effect was observed, which resulted in an increase of the reaction rate for platinum- and silver-coated samples in water vapor and for platinum coated samples in oxygen. (M.C.G.)

21668 PLUTONIUM ETCHING PROCESS. Kolodney, Morris (to United States Atomic Energy Commission). U. S. Patent 3,375,149. Mar. 26, 1968.

A method is described for etching a Pu metal composition by immersing the composition in a concentrated orthophosphoric bath for about 5 min and then immersing the composition in a solution containing a strong concentration of NH_4No_3 in orthophosphoric acid. (AEC)

Preparation and Fabrication

Refer also to abstracts 21239, 21255, 21256, 22079, 22080, and 22083.

21669 (ANL-7398) LEVITATION MELTING OF METALS AND ALLOYS. Downey, J. W. (Argonne National Lab., Ill.). Dec. 1967. Contract W-31-109-eng-38. 15p. Dep. CFSTI.

Improved techniques for levitation melting, and designs of two levitation coils have been qualitatively evaluated. The coils are capable of levitating small quantities of a wide variety of molten metals and alloys. A molten charge can be helium-quenched to a solid and yet remain levitated. Levitation melting is advantageous for the preparation of alloys that require the addition of a small quantity of a specific isotope, such as for studies of the Moessbauer effect. Alloys can be cast to predetermined shapes with such rapid cooling that segregation is minimized. (auth)

21670 (BM-RI-7091) EFFECTS OF ADDING RARE-EARTH SILICIDES, ALUMINUM, AND CRYOLITE TO MOLTEN STEEL. Leary, R. J.; Coulehan, R. T.; Tucker, H. A. (Bureau of Mines, Bruceton, Pa. Pittsburgh Metallurgy Research Lab.); Wilson, W. G. (Molybdenum Corp. of America, New York). Mar. 1968. 42p.

The effects of various rare-earth metal addition practices upon the macrostructure and the pattern of sulfur distribution in steel ingots was investigated. Heats of plain carbon steel were melted in a 1-ton, basic electric-arc furnace. Melts were treated with mixtures of rare-earth silicides, aluminum, and cryolite either in the furnace, before tap or in the ladle after tap, to determine the effects of this form of rare-earth treatment upon ingot macrostructure. Steels thus treated with rare earths in the furnace were characteristically free of the gross subsurface nonmetallics which typically result from conventional rare-earth treatments. Steel treated in ladle showed only a few such nonmetallics, and practical techniques were developed for eliminating most of these. Results showed that furnace deoxidation was controlled by the concentration ratio of rare earths to aluminum. During casting, deoxidation was controlled by the concentration of rare earths. Oxygen contents equivalent to vacuum ladle degassing resulted from air-melt furnace treatments with the rare-earth mixtures described. Rare earths in steel inhibited the onset of equiaxed grain formation during ingot freezing, and also virtually prevented interdendritic segregation of sulfides. (auth)

21671 (NASA-SP-5087) WELDING OF PRECIPITATION-HARDENING STAINLESS STEELS. Vagi, J. J.; Evans, R. M.; Martin, D. C. (Battelle Memorial Inst., Columbus, Ohio). [Feb. 28, 1967]. Contract DA-01-021-AMC-11651(Z). 95p. Dep. CFSTI.

The state of the art of the welding of precipitation-hardening stainless steels is reviewed. Welding preparations, specific welding processes, welding dissimilar metals, and joint quality are discussed. (auth)

21672 (TRG-Report-1157) PRELIMINARY INVESTIGATION INTO WELDING BY FRICTION. Lees, P. (United Kingdom Atomic Energy Authority, Culcheth (England). Reactor Group). Dec. 24, 1965, Reprinted 1968. 13p. (JNPC-MWP-SSG/P-(66)4). Dep. CFSTI. UK 3s. 6d.

The relationship between the various welding parameters and their effect on weld quality is discussed. The welding characteristics of mild and stainless steel are examined, and also the manufacture of the combination of stainless-to-mild-steel joint. Good quality welds can be made between 18Cr-8Ni-Ti and itself, mild steel and itself, and 18Cr-8Ni-Ti and mild steel, using a wide range of welding parameters. The results show that the ease with which dissimilar joints can be made by this process may be one of its most significant advantages. (auth) (UK)

21673 (WAPD-T-1947) PRACTICAL FUNDAMENTALS OF PROTECTIVE ATMOSPHERE BRAZING OF NICKEL ALLOYS. Kaufman, Sidney (Bettis Atomic Power Lab., Pittsburgh, Pa.). Sept. 1966. Contract AT-11-1-GEN-14. 47p. Dep. CFSTI.

A practical treatise on the fundamentals of brazing technology employed in the design and fabrication of nickel alloy brazements is presented. A description of brazing processes, designs, applications, and limitations has been included with particular emphasis on the practical application of brazing in the design of complex maximum integrity instrumentation. (auth)

21674 (WARD-3791-12) URANIUM PLUTONIUM CARBIDE DEVELOPMENT. Quarterly Progress Report for the Period Ending December 31, 1967. Biancheria, A.; Bishop, E. C.; Jacoby, W. R. (Westinghouse Electric Corp., Madison, Pa. Advanced Reactors Div.). Jan. 1968. Contract AT(30-1)-3791. 107p. Dep. CFSTI.

The production of fuel pellets for GETR Phase I irradiation test capsules was initiated and continued. Process and equipment problems have delayed the completion of the three capsules; however, sufficient unmodified and chromium-modified pellets for the first of the three capsules and most of the pellets for the other two capsules were manufactured. A limited investigation on process variables was conducted. The three pins for the first GETR irradiation test capsule were fabricated. Work progressed on EBR-II irradiation specimen fabrication. Two fuel pin specimens and five vanadium containers were bonded and evaluated, and modifications to the sodium glovebox for the handling of the 40-inch long capsule were completed. A program was started and completed during the period to provide data to indicate an optimum process for bonding of GETR irradiation pins. Because sufficient space was not available in the glovebox used for sodium bonding development, test apparatus for sodium deposition studies were modified to make the apparatus self-contained. (J.C.W.)

21675 (UCRL-Trans-10232) METHOD OF PREPARING PLUTONIUM SCREENS FOR SOFT X-RAY SPECTROGRAPHY. de Bersuder, L. (Commissariat a l'Energie Atomique, Fontenay-aux-Roses (France). Centre d'Etudes Nucleaires). Translated by Benjamin Thayne for Univ. of California, Lawrence Radiation Lab., Livermore, from report CEA-2338. 28p. Dep. CFSTI. JCL $2.60 fs, $1.10 mf.

This report was abstracted from the original language and appeared in NSA as 18: 2196. (L.C.L.)

21676 SPECIAL FABRICATION TECHNIQUES. Reactor Mater., 11: 68-79 (Spring 1968).

Research results on melting, casting and working reactor materials are summarized. Information on development of powder metallurgy methods, pressure bonding, metal plating, and brazing and welding. Research on nondestructive testing is reported. 52 references are included. (J.R.D.)

21677 COMMERCIAL PRODUCTION OF RARE EARTH METALS BY FUSED SALT ELECTROLYSIS. Hirschhorn, I. S. (Ronson Metals Corp., Newark, N. J.). J. Metals, 20: 19-22 (Mar. 1968).

The commercial production of rare earth metals by fused salt electrolytic methods is described. These methods are used to make misch metal, cerium, lanthanum, and didymium (Nd + Pr). The feed materials consist essentially of anhydrous chlorides of the metal to be produced, augmented by additions of nonrare earth salts to yield an electrolyte with satisfactory properties for reduction. The rare earths are derived either from monazite or from bastnasite ores. The anhydrous chlorides are manufactured from the hydrated chlorides by methods that minimize oxidation or hydrolysis. Alternatively, anhydrous chlorides may be used, which result from the direct chlorination of rare earth ores by the Goldschmidt process. These are particularly suitable for electrolysis due to their very low oxychloride content. Fluorides and oxides of the rare earths are produced by wet chemical methods to provide the relatively small quantities of these compounds now used for commercial fused salt electrolysis. Reduction cells in use are constructed mainly from ceramics, graphite, or iron. The advantages and disadvantages of these types of cells are described together with the typical products which result from their use. A resume of the current uses of these metals is presented with reference to recent trends in the industrial applications of the rare earth metals. (auth)

21678 HOT-MACHINING. Kronenberg, Max. Microtechnic (Lausanne), 21: 401-8(Aug. 1967).

Thermal expansion of the work during hot-machining and reduced tool life in hot-machining of refractory metals are discussed. (M.C.G.)

21679 OBTAINING A PROTECTIVE ALUMINUM COATING ON TITANIUM AND ZIRCONIUM. Kisilevich, V. O.; Lavrenko, N. A.; Proskurkin, E. V.; Zadontsev, V. G.; Karasik, E. E. Tekhnol. Organ. Proizvod., No. 1, 70-1(1967). (In Russian).

A method of coating Ti and Zr alloy parts with Al is described. The method eliminates such operations as activation, fluxing, and drying of flux-coated parts. The parts are degreased in an alkali solution of 50 g/l caustic soda, 15 g/l trisodium phosphate and 35 g/l sodium silicate at 80 to 90°C for 30 to 40 min, rinsed in water at 75 to 80°C and then in cold water, brightened in 25 to 30 wt % nitric acid, 2 to 3 wt % hydrofluoric acid, remainder water at room temperature for 20 to 30 sec, and rinsed in cold water. Degreased and pickled parts are given anodic treatment for 30 to 60 sec in a 1% aqueous solution of sodium sulfate at 15 to 25°C at an anodic current density of 0.1 to 0.5 amp/dm^2 and a voltage of 40 to 90 V, rinsed in water at 75 to 80°C and dipped in a bath of molten aluminum at 700 to 760°C for 2 to 10 min. Any flux used in aluminizing can be used on the surface of the molten aluminum bath; the bath temperature and the time of holding parts in the melt depend on the desired thickness of the coating. Coatings obtained by the described method had no pores, adhered strongly to the base metal and had a smooth bright surface. (ATD)

21680 ELECTROLYTE FOR THE ELECTRODEPOSITION OF TECHNETIUM. Box, W. D. (to United States Atomic Energy Commission). U. S. Patent 3,374,157. Mar. 19, 1968.

An electrolytic plating bath for Tc comprises an aqueous solution of H_2SO_4 containing Tc as the pertechnetate ion, and a stabilizing amount of polycarboxylic acid selected from the group consisting of oxalic, glutaric, malonic, succinic, tartaric, and citric acids and ammonium salts of these acids, sufficient to prevent reduction of the pertechnetate in solution to a lower oxidation state. The bath has a pH in the range of 1 to 2. (AEC)

21681 POROUS TUNGSTEN RHENIUM ALLOY AND METHOD OF MAKING SAME. Kirkpatrick, Milton E. (to TRW Inc.). U. S. Patent 3,364,018. Filed Oct. 17, 1963.

A porous metallic body comprising a matrix of a tungsten–rhenium alloy in the solid solution phase with a plurality of interconnected voids throughout the body was prepared. (Offic. Gaz.)

Properties Evaluations

Refer also to abstracts 21289, 21374, 21729, 21866, and 21867.

21682 (ANL-7383) SUPERHEATING OF SODIUM AT LOW HEAT FLUXES. Holtz, Robert E.; Singer, Ralph M. (Argonne National Lab., Ill.). Nov. 1967. Contract W-31-109-eng-38. 33p. Dep. CFSTI.

Experimental data on the superheat necessary to initiate boiling of sodium were compared to a theoretical nucleation model. The sodium was contained in a vertical pipe and was heated using a high-temperature resistance wire which limited the heat flux to approximately 6 W/cm^2 (19,000 Btu/hr-ft). The system pressure, heat flux, and pressure-temperature history all significantly affected the incipient superheats. The transient pressure was also measured during the sodium nucleation. Although a large scatter in the pressure data was noted, it was concluded that pressure pulses occurred during vapor collapse, even though the liquid sodium was initially superheated. (auth)

21683 (BARC-302) CORRELATION OF DIFFUSION DATA WITH AN ATOMIC BOND PARAMETER. Ray, S. P.; Sharma, B. D.; Tiwari, G. P. (Bhabha Atomic Research Centre, Bombay (India)). 1967. 13p. Dep.

The possibility of a correlation between the activation energy of self-diffusion in metals and an atomic bond parameter involving cohesive energy and atomic volume is discussed. It is shown that the ratio of Q_{self} to the bond parameter represents the activation volume of self-diffusion. The diffusion of transition and non-transition elements in noble metals is also discussed. It is suggested that the difference in the activation energy of solute and self-diffusion arises owing to a change in the local bond parameter. The change can occur if non-transition solutes in solution contribute valence electrons to increase the Fermi energy of the solvent. Such an increase reduces the binding energy which in turn decreases the activation energy of diffusion. In the case of transition elements the process is reversed. (auth)

21684 (BMI-1824) FACTORS CONTROLLING THE GROWTH OF CERMETS DURING THERMAL CYCLING. Smith, R. A.; Speidel, E. O.; Kizer, D. E. (Battelle Memorial Inst., Columbus, Ohio). Feb. 19, 1968. Contract W-7405-eng-92. 64p. Dep. CFSTI.

The dimensional behavior of powder-blended cermet structures containing UO_2, UN, UC, or UC-6 mole % tungsten fuel particles in refractory-metal matrices was determined during thermal cycling through different temperature intervals. Under thermal-cycling conditions which promoted growth of these structures, growth was identified as a mechanical phenomenon related to differential thermal-expansion stresses developed between the dispersed fuel and the continuous matrix phase. Failure under these stresses was evidenced metallographically by the separate or combined occurrence of fuel failure, fuel-matrix separation, or matrix failure. The occurrence of these failure modes was dependent upon thermal-cycling parameters, fuel volume loading, fuel-matrix bond strength, and matrix ductility. Initial growth rate varied inversely with fuel volume loading, with this relationship tending to reverse with continued thermal cycling. Structures containing irregularly shaped fuel particles showed lower initial growth rates and higher growths after repeated thermal cycling than did structures containing spherical fuel particles. Growth of UO_2-tungsten cermets was quite dependent upon fuel stoichiometry. Cladding restrained the growth of UO_2-tungsten structures during thermal cycling to 1350°C. Factors shown to be most effective in reducing growth during thermal cycling include small fuel-particle size, low fuel-matrix thermal-expansion differential, high matrix ductility, and increased holding time at the upper thermal-cycling temperature. (auth)

21685 (BNWL-682) ELEVATED TEMPERATURE HARDNESS TESTING OF PLUTONIUM–GALLIUM ALLOYS. Hays, D. D. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). Mar. 1968. Contract AT(45-1)-1830. 5p. Dep. CFSTI.

Equipment and procedures used to determine microhardness of Ga–Pu alloys between room temperature and 415°C are described. It was determined that the effect of creep, starting at about 325°C, significantly lowered hardness values. (P.G.C.)

21686 (CEA-R-3316) INFLUENCE DES PRESSIONS HYDROSTATIQUES ELEVEES SUR L'AUTODIFFUSION DE L'URANIUM γ ET DES METAUX NOBLES. (Effect of Elevated Hydrostatic Pressures on the Self-Diffusion of γ Uranium and Noble Metals). Beyeler, Michel; Pernot, Bernard; Adda, Yves (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires). Oct. 1967. 31p. (In French). Dep.

The influence of hydrostatic pressure on self diffusion of metals has been investigated. The experiments have been made on polycrystalline γ uranium and on single and polycrystalline Ag, Au, Cu, and Hg. The behavior of single crystals under pressure is normal and leads to activation volumes of diffusion in good agreement with the theoretical evaluations. Though polycrystalline materials present an anomaly of diffusion under pressure, the experiments at very high pressure lead to activation volumes close to those measured on single crystals. The activation volume thus evaluated for γ uranium in good agreement with a vacancy diffusion mechanism. (auth)

21687 (COO-1319-61) STRESS CORROSION CRACKING OF IRON–NICKEL–CHROMIUM ALLOYS. Latanision, R. M.; Staehle, R. W. (Ohio State Univ. Research Foundation, Columbus). Oct. 1967. Contract AT(11-1)-1319. 175p. (CONF-670963-1). Dep. CFSTI.

From Conference on Fundamental Aspects of Stress Corrosion Cracking, Athens, Ohio.

Stress corrosion cracking in the Fe–Ni–Cr alloy system in aqueous media is reviewed. Special emphasis is given to austenitic alloys. Cracking of these alloys is reviewed critically as a function of metallurgical and environmental variables. The various mechanisms of stress corrosion cracking are considered with respect to their applicability to this alloy system. (auth)

21688 (COO–1352–25) DIFFUSION IN BINARY LIQUID METAL SYSTEMS. Edwards, John Barnett (Michigan Univ., Ann Arbor. Dept. of Chemical and Metallurgical Engineering). Dec. 1966. Contract AT(11-1)-1352. 342p. Dep. CFSTI.

Thesis.

Diffusion coefficients have been measured for potassium in mercury, sodium in lead, and sodium in tin for a range of temperature and alloy compositions. The coefficients obtained were reproducible, internally consistent, and have values reasonable for diffusion in liquid metals. The probable error in the measurements was ±25% and this error was due primarily to uncertainties in the thermodynamic data available for evaluation of the cell potential. The reproducibility, however, was better than ±5% in all cases. The method makes accessible the flux of diffusate entering the diffusion path. An anomoly has been observed in this flux which has been attributed to a non-planar cathode-electrolyte interface in the concentration cell. Its presence has not been detected before since other methods do not permit measurement of the flux. Numerical calculation shows that the actual quantity of diffusate due to this effect, will be a few percent greater than what is predicted by the usual mathematical solutions of Fick's law where a planar interface is assumed. A survey of the literature pertaining to diffusion in binary liquid metal alloys is presented. This includes a critical review of existing experimental data and theoretical models for diffusion in liquid metals. The experimental techniques most commonly used to measure diffusion coefficients in liquid metals are discussed. Convective and surface effects are also considered. (auth)

21689 (EURAEC–1959) STAINLESS STEEL CLADDING OF HEAVY GAGE STEELS. Quarterly Reports Nos. 11 and 12, January 1–June 30, 1967. (Neratoom, N. V., The Hague (Netherlands). Ghent Rijksuniversiteit (Belgium). Soudometal, S. A., Brussels (Belgium)). Contract 008-63-12TEEB(RD). 5p. (EUR–3768). Dep. CFSTI.

Work Performed under United States–Euratom Joint Research and Development Program.

An experimental program was begun to determine the influence of various parameters on the outcome of the cladding operation. The formulations of the fluxes are the same as those used previously. (J.C.W.)

21690 (EURAEC–1960) STAINLESS STEEL CLADDING OF HEAVY GAGE STEELS. Quarterly Report No. 13, July 1–September 30, 1967. (Neratoom, N. V., The Hague (Netherlands). Ghent Rijksuniversiteit (Belgium). Soudometal, S. A., Brussels (Belgium)). Contract 008-63-12TEEB(RD). 9p. (EUR–3769). Dep. CFSTI.

Work Performed under United States–Euratom Joint Research and Development Program.

The metallurgy of tape cladding was investigated. Plates were prepared, weld seams deposited, and the weight of the metal deposit determined. Welding tests were performed to determine the dilution necessary. (J.C.W.)

21691 (EURAEC–1961) STAINLESS STEEL CLADDING OF HEAVY GAGE STEELS. Special Report No. 2, July 1, 1965–June 30, 1966. (Neratoom, N. V., The Hague (Netherlands). Ghent Rijksuniversiteit (Belgium). Soudometal, S. A., Brussels (Belgium)). Contract 008-63-12TEEB(RD). 6p. (EUR–3770). Dep. CFSTI.

Work Performed under United States–Euratom Joint Research and Development Program.

Research is reported on developing products and conditions for stainless steel tape cladding suited to industrial application. Quality and safety applications for cladding of nuclear reactor vessels are being studied. New specifications for stainless steel cladding of nuclear reactor vessels were reported to make production more economic and to increase the severity of the specifications covering the composition of the deposits. Progress is reported on the testing of types 308 and 309 tapes. (J.C.W.)

21692 (EURAEC–1962) STAINLESS STEEL CLADDING OF HEAVY GAGE STEELS. Special Report No. 3, July 1, 1966–June 30, 1967. (Neratoom, N. V., The Hague (Netherlands). Ghent Rijksuniversiteit (Belgium). Soudometal, S. A., Brussels (Belgium)). Contract 008-63-12TEEB(RD). 4p. (EUR–3771). Dep. CFSTI.

Work Performed under United States–Euratom Joint Research and Development Program.

Progress is reported on the research program. Laboratory-scale investigations are interpreted to determine the nature and influence of varying factors causing fluctuations in the chemical composition of the metals deposited by the tape cladding, and to verify the acceptable specifications. (J.C.W.)

21693 (KAPL-P–3406) INHOMOGENEOUS DEFORMATION EFFECT IN ZIRCALOY-4 ROLLED PLATE. Jellison, J. L.; Nugent, A.; Lupi, R. F. (Knolls Atomic Power Lab., Schenectady, N. Y.). Feb. 8, 1968. Contract W-31-109-eng-52. 20p. (CONF-680202–2). Dep. CFSTI.

From 97th Annual Meeting of the American Institute of Mining, Metallurgical and Petroleum Engineers, New York.

Hot-rolling experiments were conducted to define the causes of surface cracking in Zircaloy-4. A varied number of passes were used to achieve a reduction from 300 to 125 mils at 1460° ± 10°F. To reduce surface oxidation specimens were jacketed with mild steel which was removed mechanically after rolling. The strips were processed further by cold and warm sizing and reduced from 4% to 24% in one, five, and ten passes followed by annealing for 2½ hours at 1400° ± 10°F. Texture of the strips was significantly affected by the rolling schedule. Inhomogeneous deformation was observed in strips rolled by a 20-pass schedule and surfaces had transverse corrugations. Strips rolled at 5 passes of 20% reduction exhibited no evidence of corrugations. Those rolled at 20 passes exhibited bands which appeared to contain material of different crystallographic orientation than the rest of the strip and local thinning was noticeable where the bands intercepted the surface. It is postulated that the positions at which banding occurs may depend upon localized composition differences, crystallographic differences, residual stress distribution, dislocation densities, and grain size. (P.G.C.)

21694 (NASA-SP–5089) THERMAL AND MECHANICAL TREATMENT FOR PRECIPITATION-HARDENING STAINLESS STEELS. Slunder, C. J.; Hoenie, A. F.; Hall, A. M. (Battelle Memorial Inst., Columbus, Ohio). [Feb. 20, 1967]. Contract DA-01-021-AMC-11651(Z). 206p. Dep. CFSTI.

The thermal and mechanical treatments employed in the production and fabrication of precipitation-hardenable stainless steels are discussed. Particular emphasis is directed to the interaction of the processing variables and their effects on fabricability and mechanical properties. Equipment and procedures are described as well as problems likely to be encountered and precautions to be observed in processing. Detailed processing information is presented for the precipitation-hardenable stainless steels considered to be applicable for missile and aerospace applications. (auth)

21695 (ORNL–4218) PHYSICAL, MECHANICAL, AND IRRADIATION PROPERTIES OF THORIUM AND THORIUM ALLOYS. Hammond, Joseph P. (Oak Ridge National Lab., Tenn.). Apr. 1968. Contract W-7405-eng-26. 70p. Dep. CFSTI.

Physical and mechanical property data on thorium and thorium alloys were reviewed, and information pertinent to nuclear reactor application is compiled. (auth)

21696 (ORO–2861–5) [ULTRASONIC STUDIES IN ALKALI METALS]. Final Report, August 1, 1967. Meijer, Paul H. E.; Mielczarek, E. V.; Meister, Robert (Catholic Univ. of America, Washington, D. C. Dept. of Physics). Contract AT(40-1)-2861. 6p. Dep. CFSTI.

Work performed between June 9, 1961 and August 31, 1966 on ultrasonic studies in alkali metals is briefly summarized. Very pure monocrystalline potassium was prepared. High frequency ultrasonic attenuation was applied to the magnetoacoustic measurement of the Fermi Surface in K. The investigation of cesium and rubidium was started and some successful measurements were made in the determination of sound velocity. Five papers are listed which were published during this period. (F.S.)

21697 (ORO–3262–5) [AN INVESTIGATION OF THE COMPONENTS OF THE FLOW STRESS IN TITANIUM AND ZIRCONIUM]. Progress Report. [Reed-Hill, R. E.; Ramachandran, V.] (Florida Univ., Gainesville. Dept. of Metallurgical and Materials Engineering). Feb. 15, 1968. Contract AT(40-1)-3262. 31p. Dep. CFSTI.

Tensile tests were conducted on pure titanium at 77 to 1133°K, on pure zirconium at 4 to 813°K, and on Zircaloy-2 at 77 to 900°K to determine the flow stress of these materials. The role of twinning during tensile deformation of zirconium was investigated. It was concluded that deformation twinning is of general major importance in the plastic deformation of zirconium at very low temperatures. (L.C.L.)

21698 (WAPD-TM–590) RECOVERY AND RECRYSTALLIZATION KINETICS OF COLD-WORKED ZIRCALOY-4 PLATE

AND TUBING (LWBR–LSBR DEVELOPMENT PROGRAM). Katz, O. M. (Bettis Atomic Power Lab., Pittsburgh, Pa.). Feb. 1968. Contract AT(11-1)-Gen-14. 94p. Dep. CFSTI.

Empirical kinetic equations were derived to describe the recovery region between 550 and 1020°F for times to 4000 hours for 15 to 78% cold-worked Zircaloy-4 plate and tubing. The properties studied were electrical resistivity and X-ray line sharpening. Recrystallization kinetics were described with sigmoidal curves derived from X-ray intensity and microhardness data. Light, replica, and transmission electron microscopy, and selected-area electron diffraction were used to postulate recovery and recrystallization mechanisms. From a structural aspect, the annealing process in cold-worked Zircaloy-4 is visualized as a dislocation climb and annihilation process to the limit allowed by the size of the deformation subcells, a reorientation of the subgrain material into a recrystallization texture, a growth of reoriented cells located in the most highly worked bands, and a consumption of less favorably strained and/or oriented cells by the high-angle boundaries of the reoriented cells. Comparison of 15 and 73% cold-worked tubing showed the activation energy to be less (21 versus 60 kcal/mol) and the subcell size greater (8000Å versus 1000Å) for the 15% cold-worked material. (auth)

21699 (WARD–3791-13) VANADIUM CLADDING ALLOY DEVELOPMENT. Quarterly Progress Report for the Period Ending December 31, 1967. Bishop, E. C.; Nadler, R. A.; Whitlow, G. A. (Westinghouse Electric Corp., Madison, Pa. Advanced Reactors Div.). Jan. 1968. Contract AT(30-1)-3791. 57p. Dep. CFSTI.

Physics calculations have shown that the sodium void coefficient of reactivity was 8 percent more favorable for 0.010-inch-thick V–Cr–Fe–Zr–C alloy (HSV 207) than for 0.014-inch-thick Type 316 stainless steel. The Doppler coefficient of reactivity, which was nearly independent of cladding thickness was 10 percent more favorable for HSV 207 than for type 316 stainless steel. The breeding ratios were nearly the same for both vanadium alloys and type 316 stainless steel. Fuel cycle cost calculations have indicated that for a vented design, and assuming a 4 $/ft tubing cost, the most favorable vanadium alloy cladding design, 0.010-inch-thick V–Fe–Cb–Zr–C (HSV 209), was approximately 0.07 mill/kWh more expensive than the 0.014-inch-thick type 316 stainless steel. For a non-vented design, assuming a 4 $/ft tubing cost, the same design was about 0.09 mill/kWh more expensive. Plant equipment cost savings have been examined in conjunction with the possibility of raising the reactor coolant outlet temperature from 1000 to 1100°F. One 3.8-inch-diameter ingot of each of the three alloys V-20 Ti, HSV 207, and HSV 209 was produced. A rod for the irradiation evaluation program has been made by swaging part of the HSV 209 ingot. The processing of sheet from all three alloys was initiated. Mechanical property and creep data have been obtained from the small scale up of HSV 209. Construction of the two sodium corrosion loop systems, VTL-1 and VTL-2, was started. (J.C.W.)

21700 (EURFNR–387) U–Ce–Zr TERNARY OXIDES, NITRIDES AND CARBIDES. Holleck, H.; Wagner, W. (Kernforschungszentrum, Karlsruhe (West Germany). Institut fuer Material- und Festkoerperforschung). Translated from report KFK–643. 28p. (EUR–3696). Dep. CFSTI.

Work Performed under United States–Euratom Fast Reactor Exchange Program.

Radiographic studies were carried out on quasi-ternary systems UO_2–ZrO_2–CeO_{2-x}; UN–ZrN–CeN and UC–ZrC–CeC. The limits of solubility of $(Ce_y, Zr_{1-y})O_{2-x}$ in UO_2 are discussed for temperatures ranging between 1600 and 1800°C. Following incorporation of trivalent ions of cerium and oxygen vacancies, the solubility of cerium in the mixed phase $(U,Ce,Zr)O_{2-x}$ is reduced, whereas that of Zr is increased. At 1700 and 1800°C a single-phase and cubic mixed crystal is observed up to 80 mol % ZrO_2. In quasi-binary systems UN–CeN and UN–ZrN there are large areas of mixed crystals. In the UN–ZrN system no homogeneous transition could be obtained between 80 mole % UN and pure UN under the examined conditions. At 2000°C there is evidently a small vacancy of miscibility in the UN–CeN system which is close to the composition of 60 mole % UN. In the ZrN–CeN system the solubility is very low. The solubility of CeC in the mixed phase $(U_xZr_{1-x})C$ is approximately 30 mole % for x = 1 (1500°C); it decreases as x and temperature increase. (auth)

21701 (IS-Trans–75) INCREASE IN THE CRITICAL SHEAR STRESS BY THE PRECIPITATION OF STRESSED COHERENT PARTICLES. Gleiter, H. Translated by Elly Korthoven (Ames Lab., Iowa), from Z. Angew. Phys., 23: 108-11(1967). 12p. Dep. CFSTI. JCL $1.60 fs, $0.80 mf.

The increase in shear stress of an alloy owing to far reaching stress fields of coherent precipitates was calculated and compared with the results obtained in three earlier studies. It is assumed that besides the distribution of the precipitates only the far reaching stress fields determine the mechanical properties of the alloy. (F.S.)

21702 PHYSICAL AND MECHANICAL PROPERTIES OF ZIRCONIUM–NIOBIUM ALLOYS CONTAINING 1 AND 2,5 WT-PERCENT OF NIOBIUM. Beyer, Bruno; Juknat, Regina (Forschungsinstitut fuer Nichteiserne Metalle, Freiberg i B.). pp 55-75 of Conference on the Use of Zirconium Alloys in Nuclear Reactors, October 20–21, 1966, Marianske Lazne, Czechoslovakia. General Proceedings. I. Plzen, Czechoslovakia, Skoda Works, [1966].

See CONF-661059-(Vol.1)).

A study of the properties of zirconium–niobium alloys prepared from van Arkel zirconium revealed that the coefficient of linear thermal expansion of sheets was dependent on direction of rolling. After annealing at 900°C, the sheets proved to be largely isotropic. Mechanical properties show low values. Tensile strength of sponge Zr base alloys are higher. Creep strength at 350°C is independent of O content. Heat-treated ZrNb annealed at 900°C quenched and tempered is more creep resistant than that annealed at 700°C. After annealing at 900°C a critical cooling rate higher than 1°C/sec provides good corrosion resistance. (F.S.)

21703 PROPERTIES OF Zr–Mo WELDED JOINTS. Zapletalek, A. (Inst. of Metallurgy, Bratislava). pp 197-208 of Conference on the Use of Zirconium Alloys in Nuclear Reactors, October 20–21, 1966, Marianske Lazne, Czechoslovakia. General Proceedings. I. Plzen, Czechoslovakia, Skoda Works, [1966]. (In Czech).

See CONF-661059-(Vol.1).

Welding methods for joining Ozhennite to 18-8 stainless steel are described. Characteristics demanded of the welds and mechanical properties of the welded joints are given. (tr-auth)

21704 DIFFUSION ANNEALING OF ZIRCONIUM WITH ITS ALLOYS. Splichal, Karel; Kraus, Vladimir (Inst. of Nuclear Research, Czechoslovak Academy of Sciences, Rez). pp 209-14 of Conference on the Use of Zirconium Alloys in Nuclear Reactors, October 20–21, 1966, Marianske Lazne, Czechoslovakia. General Proceedings. I. Plzen, Czechoslovakia, Skoda Works, [1966]. (In Czech).

See CONF-661059-(Vol.1).

Copper–Mo–Zr alloy was subjected to diffusion annealing in close contact with magnesium at 510°C for ~1000 hr. Diffusion penetration of magnesium led to total embrittlement of the alloy while tensile strength and the yield point decreased by 25 and 11% respectively. The fact that this decrease of properties was lower than previously reported is ascribed to the strengthening effect of molybdenum. (F.S.)

21705 VISCOSITY AND STRENGTH OF HARDENED TOOL STEEL. Fritzsch, Gunter; Koegel, Hermann (Karl-Marx-Stadt, Bereich Umformtechnik, Zwickau, Ger.). Neue Huette, 12: 360-5(1967). (In German).

No generally valid regular relations exist between hardness, strength, and viscosity. An evaluation of the material from the pattern of the hardness alone is therefore not possible. This requires that the tempering diagrams known up to the present, which represent only the pattern of the hardness as a function of the tempering temperature, are limited by the strength and viscosity values. On the basis of such tempering diagrams, a material can be selected for suddenly stressed tools with success. (tr-auth)

21706 CHARACTERISTICS OF ELASTICITY OF TUNGSTEN, MOLYBDENUM, NIOBIUM, AND THEIR ALLOYS AT 20 TO 2700°C. Dreshpak, V. A. Dopov. Akad. Nauk Ukr. RSR, Ser. A, No. 10, 917-21(1967). (In Russian).

Results are presented of experimental determinations of moduli of elasticity of the first and second kind of tungsten, molybdenum, niobium, and their alloys over a wide temperature range (up to 2700°C) in a vacuum, i.e., at temperatures considerably higher than those at which these characteristics were determined hitherto. (auth)

21707 SURFACE-DIFFUSION STUDIES ON UO_2 AND MgO. Henney, J.; Jones, J. W. S. (Atomic Energy Research Establishment, Harwell, Eng.). J. Mater. Sci., 3: 158-64(Mar. 1968).

An optical interferometric technique was used to study the growth of grain boundary grooves and the decay of surface scratches on UO_2 and MgO at 1100 to 1700°C. The results were interpreted and it was found that surface diffusion was the predominant material transport process for both oxides under the experimental conditions used. Surface diffusion coefficients and activation energies were calculated, and the equations for the variation of the mass transfer surface diffusion coefficient D_s

with temperature are given. It was found that for UO_2 the rate of grooving increased markedly as the oxygen content of the oxide increased. (auth)

21708 MEASUREMENT AND ANALYSIS OF THE THERMAL CONDUCTIVITY OF TUNGSTEN AND MOLYBDENUM AT 100 TO 400°K. Backlund, N. G. (Technische Hochschule, Stockholm). J. Phys. Chem. Solids., 28: 2219-23(Nov. 1967).

The thermal and electrical conductivities of W and Mo were measured at 100 to 400°K. The thermal conductivity is separated into its electronic and lattice components. The temperature variation of the inverses of these terms gives information about the scattering processes for phonons and electrons. For the measurements of thermal conductivity a technique of the absolute, longitudinal, steady-state type was developed, the radiation loss from the sample being balanced by the use of an electronically controlled temperature distribution along the radiation shield. (auth) (UK)

21709 SPECIFIC HEAT AND HALL EFFECT MEASUREMENTS ON Cr–Mo ALLOYS. Shabel, Barrie S.; Schroder, Klaus (Syracuse Univ., N. Y.). J. Phys. Chem. Solids., 28: 2169-74(Nov. 1967).

The specific heat C_P of chromium–molybdenum alloys containing 25 to 80 at.% molybdenum was measured at 125 and 625°K. C_P could be separated into lattice, dilatational and electronic terms. Alloys with 25 and 50 at.% molybdenum had electronic specific heats which agreed within experimental accuracy with the values for pure chromium. Alloys with 80 and 75 at.% molybdenum had lower values, which were practically the same as those for pure molybdenum. The Hall coefficient R_H of the alloys were nearly composition independent at room temperature. R_H varied only between 11.5 and 12.7×10^{-13} V-cm/A-Oe. The liquid N_2 temperature values of R_H were slightly lower, but also positive. (auth) (UK)

21710 DETERMINATION OF ENTHALPY OF FUSION OF URANIUM DIOXIDE. Grossman, L. N.; Kaznoff, A. I. (Vallecitos Nuclear Center, Pleasanton, Calif.). J. Amer. Ceram. Soc., 51: 59-60(Jan. 21, 1968).

The enthalpy changes during fusion of high purity UO_2 were determined by thermal analysis. The losses and errors occurring during the measurements are discussed and evaluated. (P.G.C.)

21711 RECOVERY AND RECRYSTALLIZATION IN THE DEFORMATION OF TITANIUM AND ZIRCONIUM. Wagener, H.-W. (Technische Hochschule, Hanover). Metall, 22: 123-30(Feb. 1968). (In German).

A comparison of the recrystallization temperatures obtained by two different methods was made for Ti (types I and II) Zr, Zircaloy-2, and the alloys Ti–Al 5–Sn 2.5 and Ti–V 13–Cr 11–Al 3. The values were described by the (log n– log θ) representation and the hardness-annealing temperature representation. The results agree with moderate accuracy. The recrystallization behavior was determined by metallographic investigation. By the linear representation of the hardness of the metals in dependence on the velocity coefficients, the assumption was confirmed that the numerical values of the velocity coefficients are a measurement of the recrystallization rate. The hardness-annealing temperature curves of the titanium alloys Ti–Al 5–Sn 2.5 and Ti–V 13–Cr 11–Al 3 show a completely different behavior with respect to the other metals investigated. (tr-auth)

21712 TITANIUM AND ZIRCONIUM IN INSTALLATIONS OF THE CHEMISTRY INDUSTRY. Whitworth, B. H. Metall, 22: 165-6(Feb. 1968). (In German).

The use of Ti and Zr in chemical industry installations is briefly reviewed. The emphasis is on recent developments in high pressure installations. (J.S.R.)

21713 PROGRESSIVE HYDROGEN EMBRITTLEMENT. Rossin, A. David (Adlai Stevenson Inst. of International Affairs, Washington, D. C.). Reactor Fuel-Process. Technol., 10: 259-60(Fall 1967).

A descriptive figure is presented to correct errors in a similar figure included in an article entitled Hydrogen Embrittlement: A Reactor Safety Problem? in Power Reactor Technology and Reactor Fuel Processing, 10(2) 102-110. The illustration concerns steps to failure in a typical hydrogenated high-strength steel. (J.R.D.)

21714 MODERATOR-NUCLEAR FUEL ELEMENT. Bourrasse, Andre; Carteret, Yvette; Elston, Jean; Lucas, Renee (to Commissariat a l'Energie Atomique). British Patent 1,107,300. Mar. 27, 1968. Priority date Apr. 26, 1965, France.

The design of a moderator-nuclear fuel element consists of particles of refractory nuclear fuel dispersed in a solid yttrium hydride moderator. The particles of refractory fuel are coated with molybdenum. A standard manufacturing operation of the fuel element is described. (J.C.W.)

21715 ADVANCES IN MATERIALS SCIENCE. Loftas, A. A.; Gwynne, P. (eds.). London, University of London Press, 1966. 80p. 9s. 6d.

Topics treated are: a definition of materials science; metals for the space age (Be, Ti, Zr); new strengths for old metals; new uses for polymers; graphite (ideal and real crystals, preparing pyrolytic graphite, properties in theory and practice, graphite in materials research); crystallized glasses; new materials in building; and composite materials. (UK)

Structure and Phase Studies

Refer also to abstracts 22252 and 22253.

21716 (BARC-298) STACKING FAULT PROBABILITY DETERMINATION FROM PEAK SHIFTS IN PLASTICALLY DEFORMED THORIUM. Krishnan, R. (Bhabha Atomic Research Centre, Bombay (India)). 1967. 13p. Dep.

The effects of cold-working on x-ray diffraction line positions of a rolled slab of thorium and thorium filings were investigated. The importance of peak-shifts arising from residual stresses in the bulk sample is emphasized. It is shown that the positions of higher order peaks only determine whether the peak-shifts are due to stacking faults or residual stresses. After eliminating the peak-shift due to residual stresses, the stacking-fault probability of thorium has been computed to be about 0.005. As this fault density is not significantly different from experimental error, it is concluded that thorium belongs to the group of high stacking-fault energy metals. (auth)

21717 (COO-916-13) STRUCTURE AND PROPERTIES OF SOLID SOLUTIONS. Technical Progress Report No. 8, March 1, 1967–March 1, 1968. Hendrickson, A. A.; Peters, B. C.; Strahl, R. A. (Michigan Technological Univ., Houghton. Dept. of Metallurgical Engineering). Contract AT(11-1)-916. 30p. Dep. CFSTI.

The compositional and temperature dependence of the critical resolved shear stress, the activation energy, and activation volume for deformation in dilute solutions of Ag–In and Ag–Sn alloys are investigated. The concentration dependence of strengthening depends on whether the solute addition is a gradual or rapid strengthener. Sn is a rapid hardener. The activation energies for deformation in Ag–In and Ag–Sn appear to be the same. The activation volume, however, is considerably smaller for the Ag–Sn case. Measurements of the activation volume have disclosed empirical relations which should be important in the theory of thermally activated glide in fcc solid solutions. The fcc metal solid solutions investigation concerns the measurement of dislocation velocities. The objective is to obtain a direct comparison of the stress dependence of dislocation velocity with strain rate sensitivity. The experimental work continues on techniques such as crystal growth and crystal cutting. The strength and deformation quantities for Nb–Ta and Nb–Mo solid solutions are investigated at high ~300 and 4.2°K. The modulus interaction does not make an important athermal strengthening contribution in Nb based alloys; solute hardening appears to be due to an atomic size interaction. Thermally activated glide in Nb and Nb–Ta alloys follows the Peierls barrier mode. In Nb–Mo alloys considerable deviation is found. For testing at 4.2°K (in compression), Nb, Nb–Ta and Nb–Mo alloys show deformation twinning. The stress required for twinning at 4.2°K was less than the flow stress at 77°K; the strain rate sensitivity was either zero or negative where twinning predominated. (J.C.W.)

21718 (CU-3712-05) DEFECTS IN CRYSTALS. Annual Report, March 1, 1967–February 29, 1968. Nowick, A. S. (Columbia Univ., New York. Henry Krumb School of Mines). Mar. 1968. Contract AT(30-1)-3712. 64p. Dep. CFSTI.

A relaxation effect due to a single lattice vacancy is studied. Cuprous oxide Cu_2O crystals were chosen for investigation owing to simplicity of the crystal structure, control of defect concentration, use of conductivity to measure deviation from stoichiometry, and availability. Specimen preparations and experimental methods are described. Dielectric and anelastic relaxations of point defects in α-quartz are discussed. Experiments, theories, applications to observed relaxations, and defect reactions in quartz are summarized. An α-quartz doped with aluminum and sodium was chosen for possible experimental observation of piezoelectric relaxation. Methods for calculating slow and rapid relaxation strengths are presented. (J.C.W.)

21719 ETCH PITTING OF DISLOCATIONS IN MOLYBDENUM SINGLE CRYSTALS. Das, G. C.; Pratt, P. L. (Imperial Coll. of Science and Tech., London). Mater. Res. Bull., 2: 667-77(1967).

A new etchant consisting of H_2SO_4, CH_3OH, and $HClO_3$ has been developed for electrolytic etch pitting of dislocations in Mo single crystals. It is possible to etch any plane which makes an angle less than 35° with {100} planes. The reliability of this etchant has been investigated and it is found to be greater than that of the existing etchants. The mobility of edge dislocations on {110} planes has been measured using this etchant. (auth)

21720 A METALLOGRAPHIC EXAMINATION OF GENERAL WHITE SPOTTING IN OXIDE FILMS ON ZIRCALOY-2. Moon, J. R. (Univ. of Nottingham, Eng.). Corros. Sci., 8: 109-10 (Feb. 1968).

A metallographic study of Zircaloy-2 is described which has shown that the occurrence of white spots is related not only to the structure of the metal, but also to the way in which this structure is oriented to the surface. (auth) (UK)

21721 THE BAND STRUCTURE OF HEXAGONAL CLOSE-PACKED METALS. II. Sc, Ti, Y, AND Zr. Altmann, S. L.; Bradley, C. J. (Oxford Univ.). Proc. Phys. Soc. (London), 92: 764-75 (Nov. 1967).

The band structures, density-of-states curved and Fermi surfaces are presented for the hexagonal close-packed configurations of Sc, Ti, Y, and Zr, as calculated by the cellular method. A study is made of the effect of the potential field on the band structure and Fermi surfaces of Ti. Heat capacities and bandwidths are discussed. (auth) (UK)

21722 ON THE THERMAL EXPANSION AND CRYSTALLOGRAPHY OF CUBIC (C) AND MONOCLINIC (B) FORMS OF Gd_2O_3 IN THE TEMPERATURE RANGE 20 TO 900°C. Sawbridge, P. T.; Waterman, N. A. (Berkeley Nuclear Labs., Eng.). J. Mater. Sci., 3: 15-18 (Jan. 1968).

Thermal expansion coefficients were measured by X-ray diffractometry. The coefficients of both cubic and monoclinic material were found to be linear in the temperature range studied. The expansion of monoclinic material is, however, very anisotropic, and the minor axis of the thermal expansion ellipsoid is not parallel to the edge of the primitive cell to which Gd_2O_3 has been assigned. It is noted that the anisotropy in expansion behavior of this material indicates that anisotropic growth probably occurs during irradiation. (auth) (UK)

21723 PROPERTIES AND MICROSTRUCTURE OF 12 PER-CENT Cr–Mo–V–Nb CREEP-RESISTING STEEL. Murphy, M. C.; Branch, G. D. (Electrical Research Association, Leatherhead, Eng.). J. Iron Steel Inst. (London), 206: 266-74 (Mar. 1968).

Steam turbine blade and bolt steel of the 12% Cr–Mo–V–Nb type was creep and creep-rupture tested at 500 and 550°C for periods exceeding 20,000 hr. The data reported show significant property differences between the various production casts. Metallurgical examination of the test specimens showed softening during exposure at 550°C, the rate being accelerated in the presence of creep strain. This softening was seen to arise both from the dissolution and agglomeration of the fine precipitants present in the original tempered martensite structure and from the recovery and ultimate recrystallization of the matrix. The rate at which these softening processes occurred varied between the casts in a pattern which correlated with the originally observed differences in creep and creep-rupture properties. High strength at 20,000 hr was shown by a cast with a high resistance to softening, and conversely, low strength by a cast with low softening resistance. The creep-rupture ductility response depended on a balance between initial hardness and softening resistance; lowering the initial hardness increased the maximum softening resistance which could be tolerated without producing a low minimum ductility. Three factors were found to influence the softening rate, and therefore the creep and creep-rupture properties, namely, the initial tempering treatment, the carbon content, and the boron content. Tempering temperatures at 700°C or higher, carbon content at 0.10%, and boron content at 0.006% lead to a high resistance to softening during test. (auth) (UK)

21724 THE MgO–ZrO_2 SYSTEM AND STABILIZATION OF ZIRCONIA WITH MAGNESIA. Muster, J. Mining Met. Quart. (USSR) (Engl. Transl.), Suppl., No. 4/A, 39-54 (1966).

Translated from Rudarsko-Met. Zbornik, Suppl., No. 4/A, 581-95 (1966).

The liquidus line and the position of the eutectic were determined by measurement of temperatures in the solar furnace and by mineralogical analyses of the samples. The phase boundaries between the cubic solid solution and the two-phase area of the cubic solid solution and periclase were taken in which the samples containing about 27.5 mol % MgO cracked during cooling due to the polymorphic changes from cubic to tetragonal and monoclinic modification. The effective stabilization of the cubic modification at least 25 to 28 mol % is necessary. The range of the cubic solid solution is broadened in the diagram to pure ZrO_2 at temperatures over 2400°C, since some remains of the cubic modification were also detected in the samples of pure ZrO_2 melted in the solar furnace. With the cooling of the melt of pure ZrO_2, primary cubic ZrO_2 crystals are formed, which partly remain in this form to normal temperature. The low temperature part of the diagram below 1400°C is the same as found previously when the stability of the cubic modification of the solid solution at 1375, 1200, and 800°C was investigated. By comparing results with previous data, it is possible to determine the melting points of samples at temperatures higher than 2000°C. (J.C.W.)

Radiation Effects

Refer also to abstract 22830.

21725 (BNWL-SA-1624) OXIDE FUEL IRRADIATION EXPERIENCE AT PACIFIC NORTHWEST LABORATORY. Goldsmith, Stanley; Freshley, M. D. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). Jan. 29, 1968. Contract AT(45-1)-1830. 7p. (CONF-680105-2). Dep.

From Industry Meeting on Water Reactor Fuel Element Technology, Germantown, Md.

Fuel evaluations were performed representing grouping of various combinations of fuel materials and designs, and fabrication processes. Irradiations were performed using the Plutonium Recycle Test Reactor. At current power reactor operating conditions, vibrationally compacted UO_2-PuO_2 fuel was tested with excellent results. More severe operating conditions are proposed. (J.C.W.)

21726 (EURAEC-1979) URANIUM MONOCARBIDE SHAPING AND IRRADIATION. Quarterly Report No. 23, January 1–March 31, 1967. Devillard, J.; Morlot, G. (Commissariat a l'Energie Atomique, Grenoble (France). Centre d'Etudes Nucleaires). 47p. (EUR-3778). Dep. CFSTI.

Work Performed under United States–Euratom Joint Research and Development Program.

The SIL 4 irradiation ended with a burn-up ratio of 13,000 MWd/t. The E1 irradiation ended with a burnup ratio of 1382 MWd/t. A precise calculation of the thermal characteristics of the experiment shows that the average linear power attained is 823 W/cm, with a fuel/canning contact resistance of 0.18°C/W/cm^2. The average conductivity of the carbide between 200 and 400° would be 0.16 W/cm°C. The E2 irradiation put in the reactor in December 1966 with a 2% U_{235} enriched fuel shows a stable operation. The target surface temperature of 600°C is not attained for an average linear power of 1100 W/cm envisaged. The linear I^2R loss would be in the region of 1040 W/cm with a fuel surface temperature of 350°C. An E3 irradiation is envisaged with a modified capsule making it possible to attain a fuel surface temperature of 600°C. (auth)

21727 (ORNL-TM-2130) IN-REACTOR AND POSTIRRADIATION CREEP-RUPTURE PROPERTIES OF TYPE 304 STAINLESS STEEL AT 650°C. Bloom, E. E. (Oak Ridge National Lab., Tenn.). Mar. 1968. Contract W-7405-eng-26. 23p. Dep. CFSTI.

The creep-rupture properties of type 304 stainless steel have been determined in the unirradiated condition and for specimens tested both during and after irradiation. Tests were performed at 650°C at stresses between 15,000 and 30,000 psi. Creep rates for irradiated specimens tested by both in-reactor and postirradiation were approximately the same and consistently higher than those of the unirradiated alloy. The higher creep rates for the irradiated specimens were due to grain-boundary fracture while the material was still in the primary stage of creep. Both ductility and rupture life were reduced by irradiation. Metallographic observations suggest that in an irradiated specimen grain-boundary fracture is initiated by the linking of grain-boundary voids. The stress-induced growth of helium bubbles will account for these observations. (auth)

21728 IMPLICATIONS OF EMBRITTLEMENT DURING THE LIFE OF A ZIRCONIUM PRESSURE TUBE REACTOR. Nichols, R. W.; Watkins, B. (United Kingdom Atomic Energy Authority, Warrington, Eng.). pp 25-54 of Conference on the Use of Zirconium Alloys in Nuclear Reactors, October 20–21, 1966, Marianske Lazne, Czechoslovakia. General Proceedings. I. Plzen, Czechoslovakia, Skoda Works, [1966].

See CONF-661059-(Vol.1)).

Existing evidence on the effect of H and irradiation on the mechanical properties of Zircaloy-2 was reviewed and it was found that the only change to pressure tubes is embrittlement. The influence of embrittlement on the failure stress of defective tubes was assessed. It was found that even with 400 ppM H, defects several inches long can be tolerated. Preliminary results in correlating practical small specimen tests and actual size tube

tests indicate that Crack Opening Displacement provides a correlation. Tests of doses up to 10^{21} n/cm^2 suggest that the embrittlement effect saturates at low doses, suggesting that critical size is several inches long and that the pressure tubes will be able to withstand high irradiation doses and large amounts of hydrogen in the Steam-Generating Heavy-Water-Moderated Reactor. (F.S.)

21729 USE OF ZIRCONIUM ALLOYS IN REACTOR TECHNIQUE. Sedlacek, Vladimir (Metal Research Inst., Prague); Brumovsky, Milan. pp 7-24 of Conference on the Use of Zirconium Alloys in Nuclear Reactors, October 20–21, 1966, Marianske Lazne, Czechoslovakia. General Proceedings. I. Plzen, Czechoslovakia, Skoda Works, [1966].
See CONF-661059-(Vol.1)).

Problems concerning the mechanical properties of Zr and Zr alloys used in pressure tubes under reactor operating condition at elevated temperatures are discussed. The effects of hydrides and Cu or Nb alloy additives are considered. (F.S.)

21730 INFLUENCE OF NEUTRON IRRADIATION ON THE CORROSION BEHAVIOUR AND THE MECHANICAL PROPERTIES OF Zr–3Nb–1Sn AND ZIRCALOY-2. Richter, H. (Metallgesellschaft A. G., Frankfurt am Main); Ruckdeschel, W.; Spalthoff, W.; Starke, E. pp 111-41 of Conference on the Use of Zirconium Alloys in Nuclear Reactors, October 20–21, 1966, Marianske Lazne, Czechoslovakia. General Proceedings. I. Plzen, Czechoslovakia, Skoda Works, [1966].
See CONF-661059-(Vol.1)).

After a review of the corrosion behavior and mechanical properties of ZrNbSn alloys, the in-pile behavior is discussed. Tensile specimens and samples under corrosion attack were irradiated in the swimming pool reactor FRG-1. The specimens were examined metallographically, tested by impact and tensile tests, and the effect of a water change on corrosion behavior was investigated. (F.S.)

21731 NEUTRON RADIOGRAPHY OF LEAD. Kraska, I. R. (Argonne National Lab., Ill.). Mater. Eval., 26: 45-8 (Mar. 1968).

Neutron radiographic inspection of lead for thickness greater than the 6 in. limit is studied. The data include exposure curves, penetrameter sensitivities and an assessment of the influence of internal neutron scattering and interfering gamma radiation on image quality. It is shown that in the case of lead sections in the 6 to 12 in. thickness range, neutron radiography presents definite advantages for inspections requiring 5 percent or less penetrameter sensitivies, and that images obtained in such inspections are influenced by internal neutron scattering and interfering gamma radiation. (auth)

21732 THE INFLUENCE OF THE DEFECT CONCENTRATION ON THE ANNEALING STAGE I OF α-IRRADIATED COPPER. Klement, E.; Wenzl, H. (Technische Hochschule, Munich). Z. Angew. Phys., 24: 182-7(1968). (In German).

The dose dependence of the low temperature annealing spectrum in pure copper foils, irradiated at 8°K with 4 MeV-α-particles, was studied in a large dose range by measuring the residual resistivity. The temperature of the I_E-subpeak shifts toward subpeak I_D and the height of stage I (18 to 60°K) decreases with increasing dose. The dose dependence of I_E can be explained using the model of a freely migrating interstitial. The stage I structure after high α-dose is similar to the structure after irradiation with fast neutrons. (auth)

21733 RADIATION EFFECTS. Symposium held at Asheville, N. C., September 1965. Sheely, W. F. (ed.). Metallurgical Society Conferences, Volume 37. New York, Gordon and Breach, Science Publishers, Inc., 1967. 860p. $52.00. (CONF-650904-(Vol.37).

Twenty-eight papers on radiation effects are presented. A separate abstract was prepared for each of 15 papers. Thirteen papers were previously abstracted in NSA. (J.C.W.)

For abstracts of individual papers see: 21734–21748.

21734 CURRENT PROBLEMS IN NUCLEAR TECHNOLOGY ARISING FROM RADIATION EFFECTS. Whitman, M. J. (Atomic Energy Commission, Washington, D. C.). Met. Soc. Conf., 37: 3-8(1967).

From Symposium on Radiation Effects, Asheville, N. C. See CONF-650904-(Vol.37).

The performance of reactors and materials is reviewed in out-of-pile testing. Many factors are difficult to simulate. It was predicted by data extrapolation that 304 stainless steel would perform well as cladding for UO_2. Instead of achieving the expected performance, a stress and irradiation-associated failure of the stainless steel cladding has limited the average burnup of stainless steel clad fuel in boiling water reactors to below 10,000 MWd/t. A test reactor to simulate a 10,000 hour exposure at temperatures above 3000°F in a flux of 10^{15} nv above 1 MeV is needed to test the 710 reactor fuel element. Complications singly or in combinations are listed. (J.C.W.)

21735 CROSS SECTION MEASUREMENTS IN METALS. Bauer, Walter; Sosin, A. (Atomics International, Canoga Park, Calif. North American Aviation Science Center, Thousand Oaks, Calif.). Met. Soc. Conf., 37: 45-9(1967).

From Symposium on Radiation Effects, Asheville, N. C. See CONF-650904-(Vol.37).

Threshold energy measurements and the limitations imposed by theoretical and experimental considerations are discussed. Displacement cross section calculations and measurements, including their relationship to the effective threshold energy, are given. Experimental results of measurements on copper and gold, and the latest results on platinum and aluminum are reviewed. Displacement processes near threshold in these metals are briefly explained. (J.C.W.)

21736 TRAPPING OF POINT DEFECTS BY DISLOCATIONS. Sosin, A.; Keefer, D. W. (North American Aviation Science Center, Thousand Oaks, Calif. Atomics International, Canoga Park, Calif.). Met. Soc. Conf., 37: 51-6(1967).

From Symposium on Radiation Effects, Asheville, N. C. See CONF-650904-(Vol.37).

The major aspects of point defect-dislocation interactions are discussed comparing the observations in copper, gold, and aluminum. Dislocation pinning effects are emphasized. (J.C.W.)

21737 CORRELATED COLLISIONS IN HEXAGONAL COMPOUND LATTICES. Torrens, Ian McC.; Chadderton, Lewis T. (Cavendish Lab., Cambridge, Eng.). Met. Soc. Conf., 37: 57-73(1967).

From Symposium on Radiation Effects, Asheville, N. C. See CONF-650904-(Vol.37).

An electron microscope study of fission fragment irradiated crystals of lead iodide has revealed two principal types of visible damage—tracks, in thin crystals, and a random distribution of dislocation loops in the thicker ones. The former can be explained by the proximity of the crystal surface to the path of the charged particle, and the latter seems to indicate a high degree of mobility of the point defects formed in the wake of the energetic fragment. To obtain information on the mobility of knocked-on atoms, computations of dynamic displacement events in a simulated (1210) plane of the lattice have been undertaken. These demonstrate the importance of channelling for atoms with initial energies of some 1000 eV as a source of energy transport from the region of the primary event. (auth)

21738 MICROSCOPIC OBSERVATIONS OF FISSION-FRAGMENT TRACKS IN SOLIDS. Goland, Allen N. (Brookhaven National Lab., Upton, N. Y.). Met. Soc. Conf., 37: 113-71(1967).

From Symposium on Radiation Effects, Asheville, N. C. See CONF-650904-(Vol.37).

The electron microscope and the field-ion microscope are being employed to an ever-increasing extent in studies of radiation damage. Nuclear fission and energy loss by fission fragments in solids are reviewed. A discussion of electron and field-ion microscopy techniques follows. Radiation-damage models and examples of them are described. The role that hot electrons play in track formation in metallic films is discussed. The point is made that a theoretical treatment of diffraction-contrast effects is required before observations of track-like regions can be interpreted unambiguously in terms of existing models of radiation damage. (J.C.W.)

21739 ENERGETIC DISPLACEMENT CASCADES IN GOLD. Merkle, K. L. (Argonne National Lab., Ill.). Met. Soc. Conf., 37: 173-82(1967).

From Symposium on Radiation Effects, Asheville, N. C. See CONF-650904-(Vol.37).

Defect clusters are observed in the form of black spots by transmission electron microscopy. Their size is shown to increase with increasing knock-on energy. An analysis of the cross sections for black spot formation as a function of particle energy shows that the observed defect clusters are produced in energetic cascades. This applies to irradiations with a maximum knock-on energy of the order of 10^4 eV or greater. The function W(E) which gives the probability that a primary knock-on of energy E produces a defect cluster greater than 20Å in diameter is determined from irradiations with charged particles in the Rutherford range. Using this criterion for spot formation the density of defect clusters was calculated for the case of a fast neutron irradiation and found to be in quantitative agreement with the experimental value. (auth)

21740 ON THE ELECTRON MICROSCOPY OF FISSION FRAGMENT DAMAGE. Chadderton, L. T.; Morgan, D. V.; Torrens, I. McC.; Van Vliet, D. (Cavendish Lab., Cambridge, Eng.). Met. Soc. Conf., 37: 183-96(1967).

From Symposium on Radiation Effects, Asheville, N. C. See CONF-650904-(Vol.37).

The damage which is produced in a single crystal by the excited electrons energized by a fission fragment is explained on the basis of a simple classical model. An average primary electron, or delta particle, possesses a typical energy of some 80 electron volts and this is communicated to the lattice, first by electron/electron interactions and then by electron/phonon interactions. A critical parameter is the effective range x_s traversed by a typical secondary electron, and the magnitude of x_s is a function of the nature of the lattice vibrations excited. In polar crystals both polar and acoustic modes are important, but in nonpolar crystals only acoustic modes need be accounted for. Optical modes are relatively unimportant. (auth)

21741 DIRECT OBSERVATION OF RADIATION DAMAGE PRODUCED IN COPPER, GOLD, AND ALUMINUM DURING ION BOMBARDMENTS AT LOW TEMPERATURES IN THE ELECTRON MICROSCOPE. Howe, L. M.; McGurn, J. F.; Gilbert, R. W. (Atomic Energy of Canada Ltd., Chalk River, Ont.). Met. Soc. Conf., 37: 197-212(1967).

From Symposium on Radiation Effects, Asheville, N. C. See CONF-650904-(Vol.37).

Copper, gold and aluminum foils were bombarded directly in the electron microscope with 100 keV O^- ions at temperatures as low as ~20°K. Visible defects appearing as spots, small irregular dislocation loops or complex tangles, depending upon the ion dose, were produced in all of the foils. Analysis of the images of the defects appearing as spots revealed that most of these particular defects are vacancy in character and have a strain field which is not spherically symmetrical. Futhermore the results indicate that the strain field associated with the larger defects in the copper and gold foils has a principal component along a ⟨111⟩ direction which suggests that these larger defects are actually unresolved vacancy loops lying on {111} planes and having a/3 ⟨111⟩ Burgers vectors. Quenched and aged gold foils containing stacking-fault tetrahedra were also bombarded at temperatures as low as ~20°K. In the early stages of bombardment the tetrahedra collapsed into irregular shapes which still exhibited stacking-fault contrast or into triangular sessile dislocation loops lying on {111} planes. With increasing ion bombardment the collapsed tetrahedra decreased in size until they could no longer be distinguished from the radiation-produced defects. These results are consistent with a mechanism whereby interstitial atoms are gradually accumulated at the tetrahedra or at collapsed forms of the tetrahedra which encompass a stacking fault. However, interstitial atoms will not be freely migrating in gold at 20°K. It is suggested that the accretion of interstitial atoms at the stacking-fault tetrahedra occurs as the result of dynamic crowdions and channeled atoms, which emanate from the region of the depleted zones, being defocused (or dechanneled) at the stacking faults. (auth)

21742 ANALYSIS OF THE EFFECT OF AN ENERGY GRADIENT ON BUBBLE COALESCENCE IN SOLIDS. Gruber, E. E. (Argonne National Lab., Ill.). Met. Soc. Conf., 37: 269-74(1967).

From Symposium on Radiation Effects, Asheville, N. C. See CONF-650904-(Vol.37).

An approximate analysis of the rate of coalescence of bubbles migrating in a uniform energy gradient by surface diffusion is given. The results show that the mean radius and swelling are linear functions of time, in contrast to the results for coalescence by random walk, which show a $t^{1/3}$ dependence. Swelling should be negligible for most cases of post-irradiation annealing in which the random coalescence model is applicable, but may be greatly enhanced in the presence of biasing effects, such as a thermal gradient. (auth)

21743 SWELLING OF URANIUM ON POSTIRRADIATION ANNEALING. Loomis, B. A. (Argonne National Lab., Ill.). Met. Soc. Conf., 37: 403-9(1967).

From Symposium on Radiation Effects, Asheville, N. C. See CONF-650904-(Vol.37).

The effect of preirradiation heat treatment and of a brief post-irradiation anneal at a temperature in the beta range on the swelling of irradiated uranium during annealing at 620°C is described. The experimental data show that irradiated specimens deformed and recrystallized before irradiation decrease in density on annealing at 620°C substantially more than irradiated specimens quenched from a beta temperature before irradiation for burnups greater than 0.04%. The data also show that extensive swelling of irradiated uranium on annealing at 620°C can be minimized by a prior brief annealing of the irradiated uranium in the beta phase. The interpretation of these results is supported with photomicrograph of the swelled specimen. (auth)

21744 IRRADIATION HARDENING IN COPPER AND COPPER ALLOYS. Blewitt, T. H.; Koppenaal, T. J. (Argonne National Lab., Ill.). Met. Soc. Conf., 37: 561-625(1967).

From Symposium on Radiation Effects, Asheville, N. C. See CONF-650904-(Vol.37).

The strengthening of copper single crystals by irradiation with fast neutrons has been reviewed. The following experimental parameters have been discussed: the neutron dose dependence of the critical resolved shear stress (CRSS), the macroscopic and microscopic flow characteristics, the temperature and strain rate dependence of the CRSS, the effect of annealing on the CRSS and resistivity, the activation energy and activation volume for slip, and the effect of aluminum as a soluble solute on these various parameters. The experimental results are evaluated on the basis of quantitative theories. Comments are also made on the general source strengthening mechanism. (auth)

21745 RADIATION DAMAGE IN FACE CENTERED CUBIC METALS AND ALLOYS. Makin, M. J. (Atomic Energy Research Establishment, Harwell, Eng.). Met. Soc. Conf., 37: 627-69(1967).

From Symposium on Radiation Effects, Asheville, N. C. See CONF-650904-(Vol.37).

The effects of neutron irradiation on the mechanical properties of polycrystalline face centered cubic metals and alloys are reviewed, emphasis being placed on the extent to which the current theories of irradiation hardening can explain the effects. For the displacement hardening, where the damage is due to clusters of displaced atoms, the effects of neutron dose, testing temperature, grain size, purity, cold work, irradiation temperature and thermal annealing are discussed in some detail. It is shown that while the theories (derived mainly from single crystal studies) are qualitatively capable of accounting for most of the effects, quantitative correlations are, generally speaking, not yet possible, and this is undoubtedly due to the great complexity of the hardening problem. In addition to displacement hardening, effects due to transmutations occur in materials containing boron, which transmutes to helium. These effects are most noticeable at high temperatures, where the resulting loss in ductility of materials such as the stainless steels can be appreciable. (auth)

21746 RADIATION DAMAGE IN BODY-CENTERED CUBIC METALS AND ALLOYS. Moteff, J. (General Electric Co., Cincinnati, Ohio). Met. Soc. Conf., 37: 727-807(1967).

From Symposium on Radiation Effects, Asheville, N. C. See CONF-650904-(Vol.37).

The known effects of neutron irradiation on the physical and mechanical properties of bcc metals and alloys are reviewed, with particular emphasis on measurements made at room temperature and above. Specifically, the effects of irradiation on resistivity, stored energy, lattice parameter, linear expansion, hardness, creep rupture, and tensile properties are presented. Changes in the brittle-to-ductile transition temperature are also discussed. Recent calculations of irradiation hardening in ferritic steels are compared with experimental results. Transmission electron microscope studies of the substructure of irradiated bcc metals are described. Activation energies for the migration of irradiation-induced defects in bcc metals are compared with those reported for the fcc metals. (auth)

21747 CORRELATION BETWEEN MECHANICAL PROPERTIES AND MICROSTRUCTURE IN IRRADIATION IRON AND MOLYBDENUM. Laidler, J. J.; Smidt, F. A. (Battelle Memorial Inst., Richland, Wash.). Met. Soc. Conf., 37: 809-19(1967).

From Symposium on Radiation Effects, Asheville, N. C. See CONF-650904-(Vol.37).

A combined electron microscopic and tensile deformation study of the effects of irradiation on the structure and properties of molybdenum and two purities of iron was conducted. The activation volumes, V*, were determined. V* of the two types of iron differed by a factor of two but on irradiation, both assumed similar values intermediate between the two. Plastic strain caused the activation volume-plastic strain curves of the unirradiated and irradiated conditions to converge in both irons and the molybdenum. Interpretations of the observed behaviors are offered in terms of the interaction of dislocations with the defects introduced by irradiation. (auth)

21748 DISLOCATION DYNAMICS IN IRRADIATED IRON. Ohr, S. M.; Hinkle, N. E.; Williams, J. M.; Wechsler, M. S. (Oak Ridge National Lab., Tenn.). Met. Soc. Conf., 37: 843-8(1967).

From Symposium on Radiation Effects, Asheville, N. C. See CONF-650904-(Vol.37).

Measurements have been made of the stress dependence of the dislocation velocity in tensile samples of electron and neutron irradiated iron by applying a stress relaxation technique. This technique yields a measure of the threshold stress at which dislocations move on macroscopic scale and the mobile dislocation density. It is found that, while the density of mobile dislocations is lowered

by as much as two orders of magnitude upon irradiation, the major cause of the radiation hardening is the increase in the threshold stress. (auth)

Ceramics and Cermets

Refer also to abstracts 21645, 21646, and 21649–21651.

21749 MODERATOR AND CONTROL MATERIALS. Reactor Mater., 11: 18-29(Spring 1968).

Research and development progress summaries are presented on graphite, Be and Be alloys, Be oxides, solid hydrides, metallic poison materials, and dispersion and nonmetallic poison materials. (J.R.D.)

Preparation and Fabrication

Refer also to abstract 21055.

21750 (EUR-3737) FORMATION OF COLLOIDAL SOLUTIONS OF Pu(IV) AND THE CONVERSION INTO PuO_2 MICROSPHERES. Louwrier, K. P.; Steemers, T.; Zamorani, E. (European Atomic Energy Community, Karlsruhe (West Germany). Inst. of Transuranium Elements). Nov. 27, 1967. 17p. Dep.

Different methods to produce sols of PuO_2 are presented and the feasibility of forming microspheres is tested. Formation of microspheres with a tapered column and in a beaker is described. Thermogravimetric analysis in connection with the drying procedure is discussed. Metallographic inspection of the microspheres is presented. (auth)

21751 (EUR-3743) FABRICATION AND PROPERTIES OF CHEMICAL VAPOR DEPOSITED Nb LAYERS ON Al_2O_3 BODIES FOR THERMIONIC APPLICATION. Fiebelmann, P. (European Atomic Energy Community, Ispra (Italy). Joint Nuclear Research Center). Nov. 13, 1967. 19p. Dep.

A recently developed CVD process for refractory metal plating is of interest as regards the fabrication of $Nb-Al_2O_3-Nb$ sandwiches for thermionic application. The process uses Zn for the reduction of refractory metal chlorides. Nb deposition is in accordance with the reaction: $2\ NbCl_5 + 5Zn \rightarrow 5\ ZnCl_2 + 2\ Nb$. A laboratory apparatus for plating Al_2O_3-tubes is described and working data given. The influence of pressure and temperature change is discussed, as well as the most important factors to be considered in the plating procedure. Results relating to the layer properties are shown. The main features after outgassing at 1650°C are: chemical purity, good surface adherence even during sharp thermal cycles, and equal layer thickness. For application in the 800 to 1100°C temperature range, brazing and diffusion bonding of Nb-plated Al_2O_3-bodies proved feasible. Related results are also reported. (auth)

21752 (GAMD-8342) PROCESSING STUDIES TO REDUCE THE IRON CONTENT OF NUCLEAR GRADE GRAPHITES USED IN THE PSC CORE. Meyers, C. L.; Hooker, J. R. (Gulf General Atomic, Inc., San Diego, Calif.). Dec. 5, 1967. Contract AT(04-3)-633. 39p. Dep. CFSTI.

Graphite samples are evaluated with respect to purity, thermal properties, mechanical properties, and cost for moderators and for structural lattice of nuclear fuel elements. Results of the testing and analyses of samples are summarized and indications made as to whether the graphite is acceptable for use in the PSC core. The results of the study show that the iron content in the nuclear grade graphites can be reduced to <100 ppM by Cl_2. Contamination from the cutting tool wear during drilling is not a significant problem. Experimental procedures are described. (J.C.W.)

21753 (LA-3872) CMF-13 RESEARCH ON CARBON AND GRAPHITE. Report No. 4. Summary of Progress, November 1, 1967–January 31, 1968. Smith, Morton C. (Los Alamos Scientific Lab., N. Mex.). Feb. 1968. Contract W-7405-eng-36. 25p. Dep. CFSTI.

Properties and structure of extruded graphite prepared from graphite flour and carbon black were determined. Techniques were investigated for deagglomerating and preparing carbon blacks. Differential thermal analyses were made of furfuryl alcohol resins and furfuryl alcohol-formaldehyde copolymers. Grinding of Ceylon natural graphite and high-expansion coke graphite was studied and hot-molded, pitch-bonded graphite was prepared. The effect of particle size distribution on properties of graphite was determined. X-ray diffraction was used to study the crystalline properties of made and natural graphites. Crystalline structures were used to evaluate the effect of filler type on pitch concentrations of molded graphites. X-ray parameters are given for pyrolytic glassy carbons. Room temperature sound velocities were measured by a capacitive technique on 10-in. sections of graphite fuel-element-type extrusions and compared with those measured by tenuous-wire, thin-rod thermal resonance on 58-in. extrusions. The effect of temperature on creep of graphite was studied at 2100 and 2500°C. Experiments were conducted on swiveling pyrolytic graphite. (F.S.)

21754 URANIUM DIOXIDE FROM URANYL NITRATE–TRI-n-BUTYL PHOSPHATE SOLUTION. Ishimori, Tomitaro; Akatsu, Eiko; Kawasaki, Michiko; Ueno, Kaoru (Japan Atomic Energy Research Inst., Tokyo). J. Nucl. Sci. Technol. (Tokyo), 5: 111-16(Mar. 1968).

Uranium in uranyl nitrate–TBP solution was converted into dioxide by vacuum distillation and ignition. In vacuum distillation, TBP and its diluent were recovered at 40 to 150°C in nitrogen under 1 to 5 mm Hg. The distillation residue was incinerated in a nitrogen stream at 0.1 to 1.0 mm Hg by increasing the temperature from 400 to 1,300°C. The final product was a black powdery UO identified by x-ray diffraction, by density measurements, and by chemical analyses. Uranyl nitrate-TBP solution is evolved during fuel reprocessing, and thus the vacuum distillation method could be applied to the solution in order to simplify the process. (auth)

21755 PROCESS FOR THE PREPARATION OF DEOXIDIZED ACTINIDE CARBIDES. Pascard, Roger (to Commissariat a l'Energie Atomique). British Patent 1,105,520. Mar. 6, 1968. Priority date Aug. 25, 1964, France.

A process is described for preparing deoxidized actinide carbides for reactor fuels containing uranium and/or plutonium carbides. Carbides are ground and a hydride of Al, Ba, Ca, Mg, or Sr is mixed with the carbide and heated in vacuum at a temperature at which the hydride is decomposed and reduced to the metal oxide. (F.S.)

21756 IMPROVED PROCESS FOR SINTERING URANIUM NITRIDE WITH A SINTERING AID DEPRESSANT. (to U. S. Atomic Energy Commission). British Patent 1,105,252. Mar. 6, 1968. Priority date Nov. 13, 1964, United States.

A method for compacting uranium nitride powder to high density is described which consists of mixing the powder with a powdered U intermetallic compound such as UAl_2, UAl_3, UAl_4, UBe_{13}, USi, USi_2, USi_3, or U_3Si_2 and an organic binder. The mixture is pressed to a green strength and sintered to a green body in an inert or N atmosphere or in a vacuum at 1400 to 1600°C. (F.S.)

21757 IMPROVEMENTS IN OR RELATING TO FUEL FOR NUCLEAR REACTORS. Huddle, Roy Alfred Ulfketel; Kern, Dieter (to United Kingdom Atomic Energy Authority). British Patent 1,105,527. Mar. 6, 1968. Filed May 25, 1964.

A coating process is described for fuel particles such as thorium-uranium. A pyrolytic carbon coating is deposited and the coated fuel particle is subjected to a CCl_4 vapor effecting pyrolytic decomposition and removing contaminants which have penetrated the coating. A second carbonaceous layer is then deposited. (F.S.)

21758 IMPROVEMENTS IN OR RELATING TO THE PRODUCTION OF FUEL FOR NUCLEAR REACTORS. Wilkinson, William Lionel (to United Kingdom Atomic Energy Authority). British Patent 1,105,325. Mar 6, 1968. Filed June 30, 1964.

A method for producing dry granules of ceramic nuclear fuels is described which consists of mixing the ceramic powder with a solution of a binder in an excess of an organic chlorinated hydrocarbon solvent to form a slurry. The slurry is spray dried to produce dry granules having the binder incorporated in the granules. (F.S.)

Properties Evaluations

Refer also to abstracts 21715 and 22210.

21759 (LA-3799) THE PROPERTIES AND IRRADIATION BEHAVIOR OF CARBIDE FUELS: A LITERATURE SURVEY. Litton, Felix B. (Los Alamos Scientific Lab., N. Mex.). Oct. 6 1967. Contract W-7405-eng-36. 22p. Dep. CFSTI.

No major deficiencies for fast reactor applications were found in the reported properties of carbide fuels. It appears probable that container compatibility problems can be reduced by using carbide compositions that are strictly stoichiometric, or buffered. Free metal in carbon-deficient fuel reacts with iron- or nickel-base containers to form low-melting alloys. In sodium-bonded configurations, carbon in excess of stoichiometric monocarbide is transferred to cladding materials that contain elements forming carbides more stable than the fuel carbide. No information was found on heat transfer or sodium stability in sodium-bonded fuel elements. Irradiation data indicate that fuel swelling depends on

the carbon content, operating temperature, and burnup. Fuel swelling is a linear function of temperature to 1800°F, after which it is an exponential function. Fission gas release is related to the integrity of the fuel structure, the operating temperature, and burnup. The retention of fission gas appears to be satisfactory in mixed fuels up to about 50,000 MWd/t burnup. Strong containers that are stable to radiation effects will be required for burnups approaching 100,000 MWd/t. Metallurgical advances are anticipated from current carbide development programs; it is recommended that their economic significance be evaluated in comparison to the total processing cycle visualized for other competitive fuel systems. No clear-cut analysis appears in the literature. (auth)

21760 (TRG-Report-1578) ADSORPTION OF KRYPTON AND XENON FROM ARGON BY ACTIVATED CHARCOAL. Collins, D. A.; Taylor, R.; Taylor, L. R. (United Kingdom Atomic Energy Authority, Risley (England). Reactor Group). Sept. 20, 1967. 20p. Dep. CFSTI. UK 2s. 6d.

In sodium-cooled fast reactors the argon cover gas may require purification from radioactive krypton and xenon. Coconut-based charcoals were found to be superior to other types for the adsorption of krypton and xenon from argon. Adsorption coefficients for xenon and krypton were measured over a wide range of concentrations in argon, and the effect of coadsorption of krypton on the adsorption coefficients for xenon was examined. The effect was not serious at temperatures down to −70°C if the krypton concentration in the gas phase was below 1000 vpM. (auth)

21761 (ANL-Trans-561) THERMODYNAMIC STUDIES OF THE URANIUM–OXYGEN SYSTEM USING MASS SPECTROMETRY. Pattoret, A.; Drowart, J.; Smoes, S. Translated for Argonne National Lab., Ill., from Paper Presented at Symposium on Thermodynamics of Nuclear Materials with Emphasis on Solution Systems, Vienna, Austria, Sept. 4–8, 1967. 41p. (CONF-670915–8). Dep. CFSTI. JCL $4.60 fs, $1.49 mf.

Determinations were made of the vapor pressures of the gaseous species U, UO, UO_2, and UO_3 over different phases of the uranium-oxygen system: U–O solution, two-phase system U(l) and UO_{2-x}(s), single-phase UO_{2-x} between $UO_{2.00}$, and the limiting composition at 1700 to 2500°K. The pressures of U, UO, and UO_2, expressed in atm, are given by equations: $\log P_U = 25{,}955/T + 5.85$, (1700 to 2340°K); $\log P_{UO} = 28{,}280/T + 8.19$, (1700 to 2100°K); and $\log P_{UO_2} = 30{,}850/T + 8.60$, (1900 to 2400°K). The dissociation energies of the UO and UO_2 molecules are independently specified through isomolecular exchanges with Si and SiO_2. The consistency between the heat of sublimation of U, ΔH_s, O(U) = 128.5 kcal/g-atom and the thermodynamic data for uranium carbides is discussed. Above 2100°K, vapor-pressure measurements on the two-phase system U(l) + UO_{2-x}(s) reflect the development of a distinct nonstoichiometry in the dioxide. The ratios of the pressures of UO_2(g) over congruent $UO_{2.00}$, UO_{2-x} and at the limit of the UO_{2-x} area measured by different techniques are given as are the corresponding compositions at the phase limit and at the congruent evaporation point. The oxygen partial pressures and the partial thermodynamic functions of the nonstoichiometric dioxide are given as a function of the composition. (auth)

21762 (ORNL-tr-1866) USE OF A MIXTURE OF URANIUM OXIDES WITH SUPERSTOICHIOMETRIC OXYGEN CONTENT FOR THE PRODUCTION OF HIGH-DENSITY STOICHIOMETRIC DIOXIDE SINTERED PRODUCTS FOR NUCLEAR APPLICATIONS. Amato, I.; Colombo, R. L.; Protti, A. M. Translated for Oak Ridge National Lab., Tenn., from Mem. Sci. Rev. Met., 61: 485-8(1965). 6p. (CONF-704–4). Dep. CFSTI. JCL $1.10 fs, $0.80 mf.

From Proceedings of Fall Metallurgy, Paris, France, Oct. 1963.

Tablets of uranium oxide of superstoichiometric composition have been sintered in an atmosphere of nitrogen, then reduced in an atmosphere of hydrogen. By this method the same densities can be obtained as those obtained by sintering stoichiometric UO_2 under hydrogen at <400°C. The characteristics of the samples obtained by this method are identical with those samples obtained by the traditional method. Uranium dioxide is used as a fuel in different types of water reactors. Since its point of fusion is around 2750°C, uranium dioxide can be obtained in the required forms for the fabrication of nuclear fuels by the technique of powder metallurgy: shaped by compression and sintering in certain atmospheres. The methods of sintering currently used employ an atmosphere of hydrogen or dissociated ammonia. In the two methods, it is necessary to attain temperatures of at least 1600°C for a minimum time of four hours. By this method frits having a density of 93 to 96% of the theoretical value can be obtained starting from a powder of ceramic quality. (auth)

21763 SELF-DIFFUSION IN SIMPLE OXIDES. A BIBLIOGRAPHY. Harrop, P. J. (Plessey Co. Ltd., Towcester, Eng.). J. Mater. Sci., 3: 206-22(Mar. 1968).

A brief review of self-diffusion behavior and the likely inaccuracies of the various techniques used in the measurement of diffusion is given, followed by a selected bibliography and tabulation of coefficients for oxides. (auth) (UK)

21764 EQUILIBRIUM NITROGEN PRESSURES AND THERMODYNAMIC PROPERTIES OF UN. Inouye, H.; Leitnaker, J. M. (Oak Ridge National Lab., Tenn.). J. Amer. Ceram. Soc., 51: 6-9(Jan. 21, 1968).

Pressures of nitrogen over UN(s) + U(l) were measured at 1300 and 1500°C. These data, coupled with literature data, extend the measured range of pressures to nearly 11 orders of magnitude and 1550 centigrade degrees. The best value of $\Delta H^\circ_{298,f}$ UN from the available data is taken to be −69.6 ± 1.0 kcal/mole. The second and third law calculations agree satisfactorily. (auth)

21765 INFLUENCE OF OH^- CONCENTRATION AND IRRADIATION ON LOW-TEMPERATURE DIELECTRIC LOSS IN SILICA GLASS. Jaeger, R. E. (Bell Telephone Labs., Inc., Murray Hill, N. J.). J. Amer. Ceram. Soc., 51: 57-8(Jan. 21, 1968).

Glasses used in the experiments were: electrically fused quartz crystal, flame-fused quartz crystal, and flame-fused synthetic silica. Hydroxyl concentration was determined from the infrared absorption at 27 μ, density was determined by mass, and volume was calculated from weight loss in carbon tetrachloride. The 30°K relaxation was present in all the glasses, but deformation losses in this area were larger for the flame-fused synthetic silica which had a higher OH^- concentration than the others. It was concluded that the OH^- concentration was more important dielectrically than acoustically although the mechanisms affecting the losses were not clear. (P.G.C.)

21766 DIFFUSIONAL PROPERTIES OF OXYGEN IN NIOBIUM PENTOXIDE CRYSTALS AND SCALES FORMED ON NIOBIUM. Sheasby, J. S. (McMaster Univ., Hamilton, Ont.); Smeltzer, W. W.; Jenkins, A. E. J. Electrochem. Soc., 115: 338-43(Apr. 1968).

Single crystals of α-Nb_2O_5 were grown by the Verneuil technique and machined into cylinders. Measurements of electrical conductivity of these specimens as a function of temperature and oxygen pressure were made and compared with similar work by previous investigators. By following the resistance change as a function of time on changing the environmental pressure, determinations of the diffusion coefficient of oxygen were made at varying degrees of nonstoichiometry. Oxygen diffusion coefficients were several hundredfold lower in oxide of large nonstoichiometry. Similar work was performed on γ-Nb_2O_5 scales stripped from niobium specimens after oxidation. Although absolute measurements could not be undertaken on these extensively cracked specimens, γ-Nb_2O_5 showed similar properties to α-Nb_2O_5. The relation is considered of these conclusions to be oxidation behavior of niobium. (auth)

21767 BEHAVIOR OF BURNABLE POISON DISPERSIONS IN ZrO_2 AT HIGH TEMPERATURE. Kubota, Tadashi (Mitsubishi Atomic Power Industries, Inc., Omiya, Japan). Nippon Kinzoku Gakkaishi, 32: 149-54(Feb. 1968). (In Japanese).

Burnable poison dispersions such as TiB_2, ZrB_2, WB and WB_2–in CaO stabilized ZrO_2 were subjected to a steep temperature gradient near the melting temperature of ZrO_2 to investigate the compatibility of burnable poison materials with ZrO_2. TiB_2 and ZrB_2 were found to be compatible with ZrO_2 up to a high temperature near the melting point of ZrO_2; WB and WB_2 were found to be compatible with ZrO_2 up to 1900°C. Above 1900°C, some WB decomposed into W_2B and W, and WB_2 into WB, W_2B and W. In addition, the adequacy of each boride as burnable poison dispersions in ZrO_2 was discussed in connection with the fuel element design and the reactor operation condition. (NSA of Japan)

Structure and Phase Studies

Refer also to abstract 21718.

21768 (AECL–2798) MICROSTRUCTURES AND DISPERSOID MORPHOLOGY IN YTTRIA–ZIRCONIUM DISPERSIONS. Childs, B. G. (Atomic Energy of Canada Ltd., Chalk River (Ontario)). Oct. 1967. 60p. Dep. CFSTI. CAN $1.50.

Yttria-zirconium dispersions, examined at high magnification in the electron microscope, showed signs of chemical reaction between the two components which increased in extent with sintering time (1.5 to 12 hr) at 700 to 1200°C. The average particle diameter in dispersions having different sintering treatments varied between 0.087 and 0.412 μm and corresponding variations occurred in the average inter-particle spacing. The yttria par-

ticles in the dispersions served to pin advancing grain boundaries and hence reduce the average grain size. Interaction was also observed between the particles and sub-boundaries (dislocation arrays) in hot-rolled specimens; however, little or no interaction occurred between the particles and individual dislocations. In dispersions warm-rolled down to 50% reduction in thickness, a high particle density appeared to inhibit recovery and recrystallization during 5 hr anneals at 400 and 600°C. (auth)

21769 PHASE RELATIONS IN THE Ln_2O_3–Nb_2O_5 SYSTEMS IN THE NIOBIUM PENTOXIDE-RICH REGION. Godina, N. A.; Savchenko, E. P.; Keler, E. K. Dokl. Akad. Nauk SSSR, 178: 1324-7(Feb. 21, 1968). (In Russian).

Phase studies were made in the systems $Ln_2O_3-Nb_2O_5$ (Ln is La, Ce, Pr, and Nd) in Nb_2O_5-rich regions. The solid phase transformations were studied in compounds with oxide ratios of Ln_2O_3 : Nb_2O_5 from 1 : 4 to 1 : 10. Chemical analysis of $Pr_2O_{3.46}-Nb_2O_5$ and $CeO_2-Nb_2O_5$ mixtures showed that complete reaction between praseodymium or cerium oxides with niobium pentoxide was reached at 1200 to 1250°C. Thermograms of precipitated niobium hydroxide and $Nd_2O_3-6Nb_2O_5$ gel and tentative phase diagram of the $Nd_2O_3-Nb_2O_5$ system were constructed. Thermal resistance of synthesized compounds of $Ln_2Nb_{12}O_{33}$ (with Ln = La, Ce, Pr, and Nd) was studied at 1000 to 1330°C. Analysis of $La_2Nb_{12}O_{33}$ electrical characteristics revealed a high dielectric penetrability (ϵ = 80) suitable for the radioceramic industry. (R.V.J.)

21770 CRYSTAL STRUCTURES OF NbFeB AND TaFeB COMPOUNDS. Kuz'ma, Yu. B. Dopov. Akad. Nauk Ukr. RSR, Ser. A, No. 10, 939-40(1967). (In Russian).

The crystal structure of the ternary compounds NbFeB and TaFeB was determined by means of x-ray single crystal and powder methods. The structure of these compounds belongs to the ZrAlNi type (Fe_2P type superstructure); the lattice constants are NbFeB a = 6.015 ± 0.004 Å, c = 3.222 ± 0.003 Å; c/a = 0.536; TaFeB a = 5.984 ± 0.004 Å, c = 3.195 ± 0.003 Å, c/a = 0.534. (auth)

21771 SYSTEM ZIRCONIA–HAFNIA. Ruh, Robert; Garrett, H. J.; Domagala, R. F.; Tallan, N. M. (Aerospace Research Labs., Wright-Patterson Air Force Base, Ohio. Univ. of Illinois, Chicago). J. Amer. Ceram. Soc., 51: 23-7(Jan. 21, 1968).

The ZrO_2-HfO_2 system was investigated by metallographic, x-ray diffraction, and microprobe analysis using arc-melted samples which had been annealed and quenched. The monoclinic-tetragonal inversion was investigated by DTA and high-temperature x-ray diffraction analysis. Results revealed that zirconia and hafnia are completely miscible in all proportions in the binary system. Within experimental error, the melting points of the compositions lie roughly on a straight line connecting the melting points of oxides. There is a continuous increase in the monoclinic-tetragonal inversion temperature as the composition moves from ZrO_2 to HfO_2. The lattice parameters of the monoclinic phase follows smooth curves which have a negative deviation from Vegard's law. (auth)

21772 STRESS RELIEF MECHANISMS IN MAGNESIA- AND YTTRIA-STABILIZED ZIRCONIA. King, Alan G.; Yavorsky, Paul J. (Zirconium Corp. of America, Solon, Ohio). J. Amer. Ceram. Soc., 51: 38-42(Jan. 21, 1968).

Stabilized zirconias exhibit pronounced photoelastic effects when viewed with transmitted polarized light. Thin sections reveal stress concentrations around pores and inclusions and at grain boundaries. The yield point of these materials, at some high temperature, is exceeded and plastic deformation tends to relieve these stress concentrations. The microhardness measurements of magnesia-stabilized zirconia indicate both solution hardening and solute segregation and help to explain the physical behavior of this system as the amount of MgO is varied. (auth)

21773 SOME PHASE RELATIONSHIPS WITHIN THE SYSTEM $Na_2O/B_2O_3/Nb_2O_5$. Burnett, D.; Clinton, D.; Miller, R. P. (National Physical Lab., Teddington, Eng.). J. Mater. Sci., 3: 47-60(Jan. 1968).

Liquidus temperatures and the stability regions of primary phases were determined over selected composition ranges by high temperature microscopy. Crystallization processes in melts and corresponding glasses were followed using both conventional methods of thermal analysis and newly developed micro techniques combined with hot stage microscopy. An electron microscope was employed to follow changes in the microstructure of the quenched glasses after controlled heat treatments. It was shown that the system contains a liquid immiscibility gap, and some attention is given to the influence that can be assigned to cations in determining the extent of such gaps and general structural relationships in borate/oxide systems. (auth) (UK)

21774 EQUIAXED GRAIN GROWTH IN SWAGED UO_2 COMPACT. Kubota, Tadashi; Seki, Yoshinobu; Takahashi, Shuichiro (Mitsubishi Atomic Power Ind., Inc., Japan). J. Nucl. Sci. Technol. (Tokyo), 4: 339-45(July 1967).

Temperature gradient was applied on swaged UO_2 compacts prepared from two different starting powders, arc-fused and highly fired, with which changes in microstructure were observed by optical and electron micrography for the purpose of obtaining information on equiaxed grain growth in swaged UO_2 compacts. In addition, microstructural changes under uniform temperature distribution were studied for comparison with the results obtained under temperature gradient. The presence of a variety of particle sizes in the starting powder affected equiaxed grain growth which is a characteristic feature of swaged compacts. With the onset of sintering, the pores concentrate locally in the regions where the smaller particles are assembled. The resulting microstructural appearance of the equiaxed grains was similar to that of die-pressed and sintered pellets except for the presence of larger sized pores. An upper limit to equiaxed grain growth existed in the case of specimens subjected to temperature gradient. In such specimens, while the portions heated to 1,700 to 1,800°C revealed grain growth with directional tendency, other parts exposed to temperatures above 1,900°C, exhibited columnar grain growth. Such difference in grain growth behavior did not appear uniformly. The difference in grain size between specimens uniformly and non-uniformly heated became appreciable above 1,700°C. (auth)

Radiation Effects

Refer also to abstract 21759.

21775 (AECL–3008) CRACK HEALING AND VOID MOVEMENT DURING IRRADIATION OF ThO_2–2 WT PERCENT UO_2. Bain, A. S. (Atomic Energy of Canada Ltd., Chalk River (Ontario)). May 1967. 30p. Dep. CFSTI. CAN $1.00.

Zircaloy-2 sheathed ThO_2–2 wt% UO_2 pellets, which had preformed cracks and holes, were irradiated for 69 days at a power rating of $\int\lambda d\theta$ = 61 W/cm. Central temperatures were 2400° ± 200°C, based on an estimated λ = 0.031 W/cm °C. Where circumferential crack widths had been large the diametral expansion of the sheath was low, indicating that the hot fuel was plastic and could move into the voidage. Cracks and axial holes were eliminated above an estimated temperature of 1700 ± 150°C, compared with 1400 ± 100°C for UO_2: both temperatures are 0.55 of the absolute melting point. There was no sublimation across any crack; other possible crack healing mechanisms, e.g., creep, surface diffusion, grain boundary sliding have been considered. Compared with UO_2 irradiated at the same power per unit length, the thoria fuel had less diametral expansion, less grain growth: autoradiographs showed essentially no fission product relocation. The presence of a circumferential crack near the periphery throughout the irradiation did not significantly impede heat transfer. (auth)

21776 (EURAEC–1937) THE USE OF PLUTONIUM AS FUEL IN NUCLEAR REACTORS. Quarterly Report No. 15. (Centre d'Etude de l'Energie Nucleaire, Brussels (Belgium)). Oct. 1967. Contract 001-64-1-TRUB. 59p. (EUR–3760). Dep. CFSTI.

Work Performed under United States–Euratom Joint Research and Development Program.

A new series of 35 fuel rods containing 2% ^{235}U and 2.7% Pu has been fabricated. Advantage was taken of the production of rods for the irradiations in boiling water capsules and in the hydraulic conveyor to perfect know-how in respect of plug welding and proportioning and densification problems. Provision was made for a second irradiation run in the EIR–WURenlingen (Switzerland) DIORIT reactor. Five fuel rods have been fabricated for it. A new UO_2 rod filling installation has been put into service; to handle 80 cm elements; it is being developed to take other dimensions. Bidistiller concentrate precipitation tests have been successfully carried out to resolve the problem of recovering the plutonium present in polymer form. The theoretical study of the effect of the longitudinal profile on the thermal performance of a core was continued by considering two axial power distribution profiles; a distribution with control rods partly inserted and a distribution with rods completely extracted. Results of the post-irradiation examinations carried out on the rods of the first boiling water capsule irradiation run (CEB-1) and those effected on the BR-3/PWR rods showed the beneficial effect of fuel heterogeneity on released fission gas recovery. The burnup ratios determined by radiochemistry on the rods of the CEB-1 and CEB-2 runs agree with the results obtained from the nickel cross temperature measurements. A fourth irradiation run in boiling water capsule was started. The maximum local power obtained was 600 W/cm. Results are given for the post-irradiation examinations carried out at Würenlingen on the plutoniferous rods irradiated in the DIORIT reactor. The maximum local calorific power is estimated as

700 W/cm, the maximum burnup ratio as 2,500 MWd/t. The 4 PANTHER code options to UO_2 and UO_2-PuO_2 lattices with different plutonium enrichments and isotopic compositions were applied. The critical cylindrical and rectangular configurations, with a single fuel area, were studied at SENA pitch multiplied by $\sqrt{2}$. The analysis of the data from the sub-critical tests on VENUS–Vulcain fuel has continued. The number and the enrichment of the plutoniferous rods in the SENA core 7th tier sub-assemblies were determined from power distribution and two-dimension evolution calculations. (auth)

21777 (GA–8376) RESEARCH ON GRAPHITE. Quarterly Progress Report for the Period Ending November 14, 1967. Bokros, J. C.; Engle, G. B.; Price, R. J. (Gulf General Atomic, Inc., San Diego, Calif.). Nov. 22, 1967. Contract AT(04-3)-167. 60p. Dep. CFSTI.

Mesophase material from an extracted impregnated pitch was subjected to densitometric separation. Density was found to increase with increasing heat treatment temperature. A low-density residue found above 2200°C was attributed to closed porosity generated at high temperature. A correlation between crystallite size and apparent density of artificial graphite was confirmed. Experiments with near isotropic graphite showed a narrow range of crystallite size over a wide range of density. The effects of metallic catalysts in the preparation of cokes from coal–tar pitch or petroleum asphalt with finely divided Zr are being investigated. Samples heated in air to about 600°C using this method did not graphitize well when heated to 2800°C. Thermal expansivity increases were observed in calcined coke when re-irradiated in a reactor. An equation which relates bulk volume changes to volumetric changes is given. Radiation-induced changes were studied in isotropic pyrolytic carbon. An accelerated rate of change was noted at high neutron exposures. Property measurements were made on irradiated pyrolytic carbons with and without Ti additives. Density increased with annealing temperature. Electric conductivity increased with apparent crystallite size. (F.S.)

21778 (UCID–15285) IRRADIATION EFFECTS IN BeO AND COMPARISON OF BeO AND MgO AS POTENTIAL REFLECTOR MATERIALS. Sidhu, Gurnam (California Univ., Livermore. Lawrence Radiation Lab.). Dec. 21, 1967. Contract W-7405-eng-48. 17p. Dep. CFSTI.

Possible changes in the essential properties of BeO reflector material were studied in a radiation environment. Volume increase, migration and agglomeration of transmutation products (such as helium), defect clusters, microcracking, changes in elastic constants, and strength are discussed. Methods of minimizing radiation damage and possible use of MgO as a reflector are suggested. (F.S.)

21779 FAST NEUTRON EFFECTS ON THE CARBIDES OF TITANIUM, ZIRCONIUM, TANTALUM, NIOBIUM, AND TUNGSTEN. Keilholtz, G. W.; Moore, R. E.; Osborne, M. F. (Oak Ridge National Lab., Tenn.). Contract W-7405-eng-26. Nucl. Appl., 4: 330-6(May 1968). (ORNL-P-3551).

Solid cylindrical specimens ($\frac{1}{2}$ in. × $\frac{1}{2}$ in.) of the monocarbides of Ti, Zr, Ta, Nb, and W, made by (1) hot-pressing, (2) slip-casting and sintering, and (3) explosion-pressing and sintering were irradiated at 300 to 700°C. Fast (>1 MeV) neutron exposures ranged from 0.8 to 5.4×10^{21} n cm^{-2} in a fast neutron flux profile which ranged from 0.6 to 2.6×10^{14} n-cm^{-2}sec^{-1}. The order of decreasing fracture of specimens made by (1) and (2) was Ta, Zr, Nb, Ti, W. Specimens made by (3) not only fractured at lower neutron doses than those made by (1) and (2), but there was also less difference in gross damage among the five carbides. Tungsten carbide expanded in volume by ~0.6% and the other carbides by 2 to 3% upon exposure to fast doses of 1 to 2×10^{21} n-cm^{-2}. Higher doses produced either a decrease in volume toward the initial volume or no further change. Volume changes represented crystal volume changes since there was no grain boundary separation. Less than 50% of the crystal expansion was accounted for by increases in lattice parameters. The major cause of damage to carbides is postulated to result from point defects produced by fast neutrons. It is suggested that most of the initial volume expansion is caused by the formation of defect agglomerates too large to affect measured values of the lattice parameters. Slow neutrons of the irradiation spectrum may have contributed to premature fracturing of explosion-pressed specimens through absorptions by added Co and Ni binder at the grain boundaries. (auth)

Plastics and Other Materials

Refer also to abstracts 21295 and 21715.

21780 POLYIMIDES: HIGH PERFORMANCE MATERIALS. Brit. Plast., 41: 69-72(Feb. 1968).

The properties offered by polyimide materials, that enables them to be used in a range of high temperature and electrical applications, in both moulded and film form in the aerospace, electronics, nuclear power, and other industries that demand stringent operating conditions are discussed. (auth) (UK)

PHYSICS (GENERAL)

Astrophysics and Cosmology

Refer also to abstracts 21945, 21948, 21949, 21952, 21953, 21956–21958, 21960, 21961, 21965, 21967, 21970, 21971, 21973–21975, 21980, 22010, 22019, 22031, 22063, 22068, 22192, 22334, and 22458.

21781 (CONF-661204-(Vol.1)) PROCEEDINGS OF THE SOUTHEASTERN SYMPOSIUM ON MISSILES AND AEROSPACE VEHICLES SCIENCES, AMERICAN ASTRONAUTICAL SOCIETY, HUNTSVILLE, ALABAMA, DECEMBER 5–7, 1966. VOLUME I. (American Astronautical Society, Huntsville, Ala. Southeast Section). 528p.

Separate abstracts were prepared for 4 papers. The remainder of the papers are out of scope. (W.D.M.)

For abstracts of individual papers see: 21782, 21783, 22004, and 22005.

21782 (CONF-661204-(Vol.1), pp 3.1-10) PROBABILITY OF SOLAR FLARE OCCURRENCES. Roberts, W. T.; West, G. S. (National Aeronautics and Space Administration, Huntsville, Ala. George C. Marshall Space Flight Center).

The solar flare environment is discussed briefly and the probability technique is outlined. Probability calculations are given. (W.D.M.)

21783 (CONF-661204-(Vol.1), pp 5.1-13) RANDOM NUMBER SOLAR CYCLE PREDICTION TECHNIQUE. Euler, Harold C. (National Aeronautics and Space Administration, Huntsville, Ala. George C. Marshall Space Flight Center).

Solar cycle prediction based upon a random number technique, fourier curve fits, and power spectra analyses is presented. A few representative typical solar cycles are considered and supplementary and supporting data are presented. (W.D.M.)

21784 (CONF-661204-(Vol.2)) PROCEEDINGS OF THE SOUTHEASTERN SYMPOSIUM ON MISSILES AND AEROSPACE VEHICLES SCIENCES, AMERICAN ASTRONAUTICAL SOCIETY, HUNTSVILLE, ALABAMA, DECEMBER 5–7, 1966. VOLUME II. (American Astronautical Society, Huntsville, Ala. Southeast Section). 812p.

Separate abstracts were prepared for four papers. The remainder of the papers are out of scope. (W.D.M.)

For abstracts of individual papers see: 21983 and 22788–22790.

21785 (RAE-TR-67158) SOLAR-TERRESTRIAL PHYSICS: A GLOSSARY OF TERMS AND ABBREVIATIONS. Gilliland, J. M. (Royal Aircraft Establishment, Farnborough (England)). July 1967. 213p. Dep.

A glossary of terms, abbreviations, and symbols commonly encountered in this and related fields of physics is presented. (UK)

21786 LUNAR OCCULTATION OF A SOLAR ACTIVE REGION AT 4-cm WAVELENGTH. Kundu, M. R.; Velusamy, T. (Tata Inst. of Fundamental Research, Bombay). Nature (London), 217: 1132-3(Mar. 23, 1968).

Some observations at Ann Arbor, Michigan during the solar eclipse of July 20, 1963, are reported, using the University of Michigan 85-ft. paraboloid telescope. The Moon completely occulted two discrete regions on the Sun, one near the east limb and the other near the west limb, the former being studied. The observations consisted in tracking the region throughout the period of occultation with the beam pointed on the peak of the region. The occultation was observed in both immersion and emersion. Analogue and digital records were taken at 4-sec. intervals. The obtained occultation curves are shown. The position of the source was determined. Smoothed brightness distributions for immersion and emersion are also shown. It appeared that the source has a central component of angular size about 45″ of arc, and a very weak outer component. The distribution is not symmetric; the intensity rises sharply on the east and decreases rather slowly on the west side. The results are in agreement with observations made earlier at λ 3 cm, and are consistent with the theory of resonance absorption recently proposed to explain the slowly varying component. (UK)

21787 FLARES AND THE SUPERPOSITION OF TWO IONOSPHERIC EFFECTS. Nestorov, G.; Krivsky, L. Bull. Astron. Inst. Czech., 18: 143-9(1967). (In Czech.).

Observations of the two flares of December 29, 1965, made at the Ondrejov Observatory, are compared with ionospheric effects observed the same day at the Ionospheric Observatory of the Geophysical Institute, Sofia. During the decay of the importance-2 flare, an arched-shaped flare filament arose in the same active region and joined two opposite polarities in the photosphere, while a 1+ flare developed in another active region at the same time. The second flare was characterized by harder emission of the impulse type, causing a range of ionospheric effects on the very long, long, and short waves (SEA, SFA, SWF, SCNA). The x-radiation emission recorded during the flare phenomena apparently originated in a magnetic bremsstrahlung process at the time of fast-particle emission from the second flare. Solar radio emission measurements were made in the meter and decameter ranges at the Public Observatory at Upice. (ATD)

21788 STIMULATION OF INTERSTELLAR OH BY PHONONS. Wickramasinghe, N. C. (Cambridge Univ., Eng.). Nature (London), 217: 1131-2(Mar. 23, 1968).

It is stated that attempts made to explain the observed features of the interstellar OH molecule cannot be regarded as entirely successful. According to current ideas interstellar grains may consist of graphite flakes of radii $\sim 5 \times 10^{-6}$ cm, from stellar sources, which accrete mantles consisting chiefly of H_2O, in quiescent H I regions, and it is not unlikely that large quantities of OH might be liberated by sputtering processes. It would be reasonable to expect that solid-state effects might play a part in the stimulation of the OH molecule, and the results of two recent experiments appear to have an important bearing on this. It has been found that acoustic microwaves may be greatly amplified in a semiconducting material provided currents involving supersonic electron drift velocities can be generated; also that acoustic microwave phonons may be generated by electromagnetic microwaves and, conversely, acoustic microwave phonons may give rise to electromagnetic microwaves in conducting and semiconducting material. The possible application of these findings to stimulation of interstellar OH is discussed. According to the model described, the chief energy source for OH excitation arises from the constant arrival of electrons at the grain surfaces. The electrostatic force exerted by the impinging electrons accelerates the conduction electrons to supersonic speeds, and the electrons in turn give up their energy to amplify the 18-cm microwaves. If an appreciable fraction of this energy is converted into 18-cm wavelength photons, the photon production rate will be $\sim 10^3$/sec/grain, and with an estimated grain density of $\sim 10^{-3}$/cm^3 this would give a production rate of ~ 0.1 photons/cm^3/sec, similar to the minimum output of the stronger OH sources. Further linear compression of the dust by a factor of $\sim 10^2$ to 10^3 would raise the total output of radio photons to $\sim 10^5$ to 10^6/cm^3/sec. The narrow widths of the observed OH lines may be understood as due to the very low thermal velocities of the grains. (UK)

21789 SPECTRAL CHARACTERISTICS OF A SOLAR FLARE FROM IONOSPHERIC DATA. Bhattacharyya, J. C.; Balakrishnan, T. K. (Kodaikanal Observatory, India). J. Atmos. Terrest. Phys., 29: 1573-9(Dec. 1967).

From the height variation of electron densities during a solar flare, ultra violet and x-ray contributions to ionization processes have been estimated. The results obtained are in conformity with direct measurements of solar ultraviolet and x-ray spectra by rocket techniques. (auth) (UK)

21790 GEOMAGNETIC CROCHETS OF SOLAR FLARES OBSERVED IN HURBANOVO. Printer, S. Bull. Astron. Inst. Czech., 18: 274-81(1967). (In Czech.).

The characteristics of geomagnetic crochets and their connection with some parameters of corresponding solar flares were determined on the basis of a detailed analysis of data recorded at the observatory in Hurbanovo ($\phi = 47.9°$N, $\lambda = 18.2°$E). The lag of the maximum ΔH of geomagnetic crochets behind the maximum of flare intensity Δt_{GC} was found to have a mean value of 2.8 minutes. It is shown that the period from the beginning up to maximum T_1 of geomagnetic crochets is smaller than that from the maximum to the end of T_2. The most probable value for T_1 is 4 minutes and for T_2 13 minutes. The crochets were divided into three groups: sharp crochet, slow crochet, and irregular crochet. The diurnal distribution of the occurrence of crochets has a pronounced maximum at midday. The probability of occurrence has two annual maxima in the period of the equinox and two minima in the period of the solstice. The last 11-year cycle of the occurrence of crochets had two maxima—in 1957 and 1960. It was found that a few more flares associated with crochets occur on the eastern side of the solar disc than on the western side. Altogether, 53.8% of

the flares occur on the eastern side of the solar disc. The time dependence of the horizontal component of the geomagnetic field in the period from the maximum to the end of the crochet was used to calculate the recombination coefficient for the lower ionospheric region ($\alpha = 7 \times 10^{-8}$ cm^{3}sec^{-1}). (ATD)

21791 MARINER 5 MEASUREMENT OF LYMAN-ALPHA RADIATION NEAR VENUS. Barth, C. A. (Univ. of Colorado, Boulder); Wallace, L.; Pearce, J. B. J. Geophys. Res., 73: 2541-5(Apr. 1, 1968).

Ultraviolet emissions from the upper atmosphere of Venus were measured with a uv photometer carried on Mariner 5. The instrument was specifically designed to determine the density and temperature of H by the observation of the resonance reradiation of the 1216-Å Lyman-α dayglow. The atomic hydrogen density and the upper atmosphere temperature results are reported. In addition, the uv photometer experiment obtained the unexpected result that H_2 is also present in the upper atmosphere of Venus. (W.D.M.)

21792 PLANETARY MAGNETIC FIELDS AND ROTATION. Brown, Robert T. (Rice Univ., Houston, Tex.). Science, 158: 674(Nov. 3, 1967).

In their presentation of the results of the particle-detector experiment on Mariner IV, Van Allen et al. (Science, 149: 1228 (1965)), mention the possibility of testing the Blackett hypothesis. This possibility is discussed, and it is concluded that it is not true in general, but may hold for the Earth and Jupiter. In an appended note, Van Allen takes exception to this. (W.D.M.)

21793 ASTROPHYSICAL CONSEQUENCES OF THE EXISTENCE OF CHARGED INTERMEDIATE VECTOR BOSONS. Campbell, J. A. (Flinders Univ. of South Australia, Bedford Park). Aust. J. Phys., 21: 139-48(Apr. 1968).

Two-photon annihilation into a neutrino–antineutrino pair, which is forbidden to the lowest order in the coupling constant for weak interactions if the conventional form of weak interaction is assumed, is permitted at that order if it is supposed that the reaction is carried by a charged intermediate vector boson (W). The rate of loss of energy in stellar evolution through this process is calculated. Evolutionary time scales derived with and without this rate are compared with results from astronomical observations. Comparisons with present data are inconclusive, but further observations and calculations that may give more accurate information concerning the question of the existence of charged W mesons are suggested. (auth)

21794 THE H ALPHA RADIATION FIELD IN THE SOLAR CORONA. Rompolt, B. (Inst. of Astronomy, Wroclaw). Acta Astron., 17: 147-54(1967). (In Polish).

The results of computing the mean intensity profiles of the photospheric radiation in the Hα line are calculated for 45 different heights above the photosphere with the Elliott-803 computer, taking into account limb darkening. The mean intensity of radiation at a given point is defined and the geometry of the problem is shown. (ATD)

21795 THE Hα RADIATION FIELD IN THE SOLAR CORONA AT MOVING PROMINENCES. Rompolt, B. (Inst. of Astronomy, Wroclaw). Acta Astron., 17: 329-40(1967). (In Polish).

The dependence of the profiles of the photospheric Hα line, which illuminates moving prominences, on the height, velocity, and direction of the prominence motion is examined. The profile of the Hα line depends on the radiation intensity, the Doppler shift, and the limb darkening effects at various heights above the photosphere. The radiation intensity was determined by solving an integral equation. Profiles were computed taking into consideration the height, velocity, and direction of the motion. The mean intensity of profiles was expressed in units of the continuum intensity at the solar-disk center in the vicinity of the Hα line. It was established that a prominence absorbs the radiation before scattering it. In loop-shaped prominences the effective width of the Hα line emission seldom exceeds 2Å. A vertical prominence motion with slowing velocity was assumed wherein the initial velocity of 20,000 km was taken to be 200 km/sec, and at 50,000 km—100 km/sec. The velocity drops to zero at a height of 100,000 km, after which the matter falls back to the solar surface, but with different velocity changes. (ATD)

21796 THE SUN'S GRAVITATIONAL FIELD. Polievktov-Nikoladze, N. M. (Tbilisi State Univ., USSR). JETP Lett. (USSR) (Engl. Transl.), 6: 376-8(Dec. 1, 1967).

Translated from Zh. Eksp. Teor. Fiz., Pis'ma Redaktsiyu, 6: 963-6(Dec. 1, 1967).

The discrepancies between the consequences of Einstein's equations and the measurements of Dicke and Goldenberg lead to a discussion of gravitational bending of light waves. Let $\delta_\gamma = 1 - \beta/\beta_E$, where β is the empirical angle of deflection of the ray at the edge of the Sun, and β_E is the Einstein value (1.75″). The empirical data allow one to assume that $\delta_\gamma \sim -0.1$. If the existence of a non-metric gravitational field (independent of the curvature tensor) is admitted, then, according to Brans and Dicke (1961), $\delta_\gamma = (2\omega + 4)^{-1}$, where ω is a universal constant. An estimate based on the perihelion rotation leads to $\omega \geq 6$ and to $0 < \delta_\gamma < 6\%$, which certainly disagrees with experiment if $\delta_\gamma < 0$. (W.D.M.)

21797 ^{40}Ar–^{40}K AGES OF SILICATE INCLUSIONS IN IRON METEORITES. Bogard, D.; Burnett, D.; Eberhardt, P.; Wasserburg, G. J. (California Inst. of Tech., Pasadena). Earth Planet. Sci. Lett., 3: 275-83(Jan. 1968).

Analyses of the argon and potassium in silicate inclusions were made on Weekeroo Station, Toluca, Four Corners, and Kodaikanal. The ^{40}Ar–^{40}K ratios of all samples except Kodaikanal are compatible with an age of $4.5 \pm 0.15 \times 10^9$ yr. These results are in agreement with the Sr–Rb results obtained previously but not with the so-called ^{40}Ar–^{40}K ages determined on iron meteorites by other workers. The ^{40}Ar–^{40}K age of $3.5 \pm 0.1 \times 10^9$ yr on Kodaikanal is consistent with the ^{87}Sr–^{87}Rb age of $3.8 \pm 0.1 \times 10^9$ yr. Estimates of the U + Th content of the silicate inclusions were made based on the ^{4}He contents. Kodaikanal was found to have a very young exposure age for an iron meteorite ($\lesssim$40 m.y.) based on upper limits to the cosmogenic He, Ne, and Ar in the metal phase. (auth)

21798 I–Xe DATING OF THE SHALLOWWATER ACHONDRITE. Hohenberg, C. M. (Univ. of California, Berkeley). Earth Planet. Sci. Lett., 3: 357-62(Jan. 1968).

Xenon from a pile irradiated sample of the Shallowater enstatite achondrite was analyzed in a step-wise heating experiment. Below 1200°C very little radiogenic ^{129}Xe was observed. Above this temperature radiogenic ^{129}Xe was released in excellent correlation with ^{128}Xe, from neutron capture on iodine, satisfying the requirements for I–Xe dating. The ratio of ^{129}I to ^{127}I when Shallowater began retaining xenon is the same within experimental error as the ratio in 10 chondrites previously measured, indicating that Shallowater and these chondrites began to retain xenon simultaneously to within one or two million years. Calculated values of the formation interval for these bodies lie between 60 and 220 million years depending on the model for nucleosynthesis assumed. (auth)

21799 SUPERDENSE DEGENERATE FERMI GAS. Shishkin, G. V. (Inst. of Nuclear Power Engineering, Minsk). Dokl. Akad. Nauk BSSR, 11: 1076-9(Dec. 1967). (In Russian).

The evolution of a compressing superdense star is considered assuming that, after reaching the density of $\sim 10^{41}$ particles cm^{-3}, the star further develops by a series of replacement of some lighter particles (baryons) by heavier ones. The particle density increase, under such postulation, is slower than in the model of superdense degenerate gas of Ambartsumyan–Saakyan elementary particles. However, the density increase of the matter is identical. (R.V.J.)

21800 EXPLANATION OF THE RELATIONSHIP $\Delta(z)$ FOR DISTANT QUASARS BY THE INFLUENCE OF STRONG EMISSION LINES. Komberg, B. V. Astron. Tsirk., No. 379, 1-4 (July 13, 1966). (In Russian).

The relationship between the mode of the optical UBV spectrum of quasars and the red shift z is explained. It is shown that in the case of distant ($z > 1$) quasars the existence of this relationship is conditioned by the influence of strong emission lines entering the optic range as a result of the red shift. The existence of a relationship in the case of quasars with $z < 1$, can apparently be explained by the joint influence of the combination of emission lines and a certain absorption band in the λ2250 region. (JPRS)

21801 THE EMPIRICAL RELATION BETWEEN RADIATION INTENSITY AND THE INTENSITY OF THE MAGNETIC FIELD IN SUNSPOT UMBRAE. Stankiewicz, A. (Univ. of Wroclaw). Acta Astron., 17: 141-6(1967). (In Polish).

A study is presented on the relationship between the intensity of the magnetic field and the gas temperature in sunspots. The results of processing the observational data are given. The statistical dispersion scatter of individual points is great, although it is possible to draw a median curve similar to an exponential curve. Similar curves can be obtained from the ratio of the radiation intensity of the sunspot to that of the photosphere, based on the temperature difference between the two solar elements and using the Planck and Wien formulas. It is possible to obtain similar curves by establishing the relationship between the intensity of the magnetic field and the parameter described by the temperature difference between sunspots and the photosphere. The correlation between the temperature ratio and the intensity of the magnetic field was found. (ATD)

21802 RADIAL MOTIONS IN SMALL AND YOUNG SUNSPOTS. Bumba, V. (Astronomical Inst., Ondrejov, Czecho-

slovakia. Kitt Peak National Observatory, Tucson, Ariz.). Bull. Astron. Inst. Czech., 18: 238-43(1967).

Radial velocities for about 40 small and young sunspots and dark areas in two sunspot groups and some facular fields were measured on spectrograms obtained with the world's largest solar telescope. The absence of the normal Evershed effect in the spots studied was established. Instead of upward motions normally observable in the penumbras of regular spots, no motions or downward motions in these small spots without penumbra were found as in umbras of regular spots. These motions are smaller in photospheric lines (from about 0.5 km/sec to about 6 km/sec) and greater in sodium $D_{1,2}$ lines (10 to 14 km/sec). The results obtained seem to agree with the assumption that the physical processes causing the cooling of a young sunspot are diametrically different from those taking place in regular spots and that the dynamics in such very young sunspots is more closely related to the dynamics of integranular space. (ATD)

21803 FORESHORTENING EFFECT ON THE APPARENT AREA OF SOLAR FLARE. Miyazawa, Masahide; Higashi, Koichi; Oe, Tsunehiko; Yamaguchi, Kisuke; Nagasawa, Shingo. Tokyo Astron. Bull., Ser. II, 2121-30(Apr. 30, 1967).

A law of foreshortening for the apparent area of a flare is derived based on a statistical method, identical with an unpublished method used by Warwick. The law depends systematically on the plan area A_0 of a flare; if the apparent area A_ϑ of a flare at the heliocentric distance ϑ from the disk center is expressed as $A_\vartheta = A_0(\cos\vartheta + k\sin\vartheta)$, the coefficient of the sin ϑ term, k, increases systematically with A_0. The average value of k, however, is near 0.2; this confirms the result obtained by Warwick. Assuming a flare of a very simple shape and using the law of foreshortening, the height of a flare is estimated as a function of its plan area. (IAA)

21804 NEUTRINO ASTROPHYSICS. Kocharov, G. E. (Ioffe Inst. of Physics and Tech., Leningrad). Izv. Akad. Nauk SSSR, Ser. Fiz., 31: 1290-5(Aug. 1967). (In Russian).

There exist three main orientations in neutrino astrophysics: the neutrino astrophysics of the Sun, the neutrino sea in the Universe, and the high-energy neutrinos (≥1 BeV) generated in the Earth's atmosphere and existing in outer space. The neutrino astrophysics of the Sun represents a new approach to the study of the processes occurring in the interior of the Sun; in particular, knowledge of the flux and energy spectrum of the solar neutrinos makes it possible to carry out the thermometry of the interior of the Sun. The parameters of the neutrino sea in the Universe have been derived from Gamow's model on assuming that relict neutrinos form a Fermi gas occupying all the energy levels from zero to the Fermi boundary. As for high-energy neutrinos, these occur in the Earth's atmosphere on disintegration of π, K, and μ mesons and their energies reach 1000 BeV and higher, which is inaccessible to present-day accelerators; this has provided an impetus for organizing experiments to record atmospheric neutrinos in order to investigate the features of the process of weak interaction at high energies. Experiments of this kind are currently being carried out by the Reines team in South Africa and are producing promising results. (JPRS)

21805 CASES OF GENERATION OF HEAVY NUCLEI IN SOLAR COSMIC RAYS. Kurnosova, L. V.; Razorenov, L. A.; Suslov, A. A.; Syrovatskii, S. I.; Fradkin, M. I. Izv. Akad. Nauk SSSR, Ser. Fiz., 31: 1300-2(Aug. 1967). (In Russian).

Three cases of generation of heavy nuclei in solar cosmic rays, recorded during the flight of the Elektron-4 artificial satellite (energy of the recorded nuclei $\gtrsim 600$ MeV-nucleon^{-1}) are analyzed. These instances lasted for a sufficiently long period of time to observe an increase in the mean diurnal intensity of cosmic rays. All the three cases were preceded roughly 24 hr previously by chromospheric flares of force 1, but the probability of random coincidence is high (~10%). A possible mechanism of the acceleration of charged particles on the Sun might be the mechanism of "dynamic" dissipation of the magnetic field. Given a sufficient effectiveness of acceleration, this mechanism may assure bursts of cosmic rays having a nuclear composition corresponding to the chemical composition of the solar atmosphere. On the basis of a formula for the flux of accelerated ions it is possible to derive the flux for the group of nuclei with $Z = 1$ and $2 \leq Z < 5$. It is shown that both theoretical and experimental findings agree that for the measured intensities of two groups of heavy nuclei the flux of α-particles and protons is small. A similar conclusion was also drawn with respect to other instances of increase in nuclear fluxes. (JPRS)

21806 SMALL SOLAR-FLARE EFFECTS IN COSMIC RAYS ACCORDING TO MEASUREMENTS IN THE STRATOSPHERE. Vladimirskii, B. M. (Crimean Astrophysical Observatory, Moscow). Izv. Akad. Nauk SSSR, Ser. Fiz., 31: 1307-9(Aug. 1967). (In Russian).

Small increases in cosmic-ray intensities following chromospheric flares have so far been investigated in the high-energy region (>1 BeV) and so it was of interest to investigate weak effects of this kind in the low-energy region. To this end, data on measurements of cosmic-ray intensity in the stratosphere, obtained with the aid of a single counter at a point with a rigidity cutoff of 0.5 BV (energy range 100 to 300 MeV) were analyzed for two groups of flights: (1) flights following flares of force 1^+ and higher; (2) flights during quiet intervals of time, in the absence of flares of force $\geq 1^+$. Averaged curves of intensity in relation to altitude were plotted on this basis and it was established that the cosmic-ray intensity for flights in group 1 with respect to depths of $X \leq 20$ g·cm^{-2} in the atmosphere was consistently higher than for flights during the quiet intervals of time. This effect was observed in the high latitudes, and may be attributed to protons. The extent of this increase in intensity corresponds to a particle flux with the energy ≥100 MeV approximately $6 \cdot 10^{-1}$ cm^{-2}·sec^{-1}, generally following about 4.5 hr after the onset of a flare. Thus, it may be concluded that the generation of cosmic rays in flares on a small scale occurs in virtually every case. (JPRS)

21807 PARTICLE GENERATION ON THE SUN DURING BRIGHTENING AND FLARES AT VARIOUS PERIODS OF SOLAR ACTIVITY. Ivanov, V. I.; Kolomeets, E. V.; Makhmudov, Z. (Kazakh State Univ., Alma-Ata, USSR). Izv. Akad. Nauk SSSR, Ser. Fiz., 31: 1310-12(Aug. 1967). (In Russian).

The article deals with the variation in the intensity of the neutron component of cosmic rays according to the data of the worldwide network of stations during chromospheric flares accompanied by electromagnetic radiation and during 15 brightenings on the Sun accompanied by x radiation, in the course of a solar activity maximum. The intensity of cosmic rays increased during the brightenings, which is yet another proof that the generation of cosmic rays on the Sun may also occur during the relatively inactive processes accompanied by electromagnetic radiation. Apparently particle injection occurs during any flare, no matter how small, but favorable conditions for the escape of particles from the flare region do not occur frequently and hence not all particles can emerge into interplanetary space. During flares accompanied by radio emission of type IV the increase in cosmic-ray intensity was greater than during flares not accompanied by this type of radio emission. Analysis of the effect of flares as a function of their helio coordinates during a minimum and a maximum of solar activity shows that the flare effect decreases with decrease in solar activity, and that this is accompanied by a shorter time of decrease in the intensity of cosmic rays; this last may be attributed to the decrease in the number and magnitude of magnetic inhomogeneities in interplanetary space, as well as to a decrease in the perturbation of the regular quasi-radial magnetic field. The variation in the flare effect in cosmic rays depending on their helio coordinates may be explained by the theory that in interplanetary space there exists a quasi-radial magnetic field that is twisted into a spiral shape by the rotation of the Sun (the helio-longitudinal effect) and focused in the plane of the ecliptic (the helio-latitudinal effect). (JPRS)

21808 PRINCIPAL FEATURES OF FORBUSH DECREASE DURING THE SOLAR ACTIVITY MINIMUM. Shafer, G. V.; Kuz'min, A. I.; Krymskii, G. F.; Krivoshapkin, P. A. (Inst. of Cosmophysics Research and Aeronomy, Yakutsk, USSR). Izv. Akad. Nauk SSSR, Ser. Fiz., 31: 1319-21(Aug. 1967). (In Russian).

The mean characteristics of Forbush effects are compared on the basis of data on the hard component of cosmic rays from the stations at Cheltnam (1938–1959) and Yakutsk (1960–1965) during minima and maxima of solar activity over two 11-year cycles. It is shown that the effectiveness of magnetic storms varies within broad limits, from 0 to 0.6, with variation in the relative number of sunspots during a solar cycle; an investigation of the distribution of various types of magnetic storms and of the attendant Forbush decreases showed that the effectiveness of magnetic storms chiefly changes owing to variation in the number of storms with a sudden onset (flare storms). A characteristic feature of Forbush decreases during low solar activity is a low amplitude of variation; the decrease in the intensity of solar rays is steeper during the solar activity maximum compared with the minimum. The energy spectrum of Forbush effects, as determined according to the latitudinal effect of the neutron component, is satisfactorily described by the power law $\delta D(\epsilon)/D(\epsilon) \sim \epsilon^{-\alpha}$ with the exponent α varying from 0.8 to 0.5 from the maximum to the minimum of solar activity. As solar activity diminishes, the energy dependence of opacity markedly decreases; this points to an increase in the degree of regularity of the interplanetary magnetic field during periods of low solar activity. (JPRS)

21809 STRUCTURE OF CONTACT BINARIES. Lucy, L. B. (Columbia Univ., New York). Astrophys. J., 151: 1123-35 (Mar. 1968).

According to an argument of Kuiper's, contact binaries with unequal components cannot exist at age zero. This result comes from a comparison of the mass–radius relation for single, homogeneous stars with the condition to be fulfilled by the radii of the components if the surface of the binary is to be an equipotential. There is good evidence, however, that W Ursae Majoris stars do occur at age zero with unequal components. To resolve this contradiction, the structure of common envelopes for contact binaries is investigated. It is found that when the common envelope is convective the adiabatic constants of the envelopes of the two companions must be equal. Then, since the radius of a star with a convective envelope is sensitive to the adiabatic constant, it follows that the mean radii of the components differ, in this case, from the radii of the corresponding single stars. Thus Kuiper's argument does not apply when the common envelope is convective. It is then shown, using Kuiper's simple approach, that contact binaries with convective common envelopes probably can exist at age zero with unequal components. This leads to a simple model for a zero-age W UMa star that predicts how the properties of these stars, including their mass ratios, depend on the mass of one component. When these predictions are compared with observation, some qualitative agreement is found, but the detailed agreement, especially with Eggen's period–color relation, is not very good. (auth)

21810 AXISYMMETRIC MAGNETIC FIELD WITH DIFFERENTIAL ROTATIONS IN A SPHERICAL FLUID SHELL. Nakagawa, Y.; Trehan, S. K. (National Center for Atmospheric Research, Boulder, Colo.). Astrophys. J., 151: 1111-21(Mar. 1968).

The differentiation rotation in a spherical shell of an incompressible inviscid fluid of infinite electrical conductivity is considered when the magnetic field and fluid motions have symmetry about the rotating axis. By using the known results that under such circumstances the velocity and magnetic field can be expressed as a superposition of a poloidal and a toroidal field, steady-state solutions are obtained for a poloidal magnetic field with toroidal fluid motions. The latter allows differential rotation in the shell, if the core rotates slower than the outer surface. Numerical examples considered for the Sun present a rather interesting possibility of this line of research for the study of general solar magnetic field. (auth)

21811 STABILITY OF TOROIDAL MAGNETIC FIELDS IN STELLAR INTERIORS. Schubert, Gerald (Univ. of California, Los Angeles). Astrophys. J., 151: 1099-1110(Mar. 1968).

The stability of a toroidal magnetic field, B_ϕ, in the radiative zones of stars is investigated. In cylindrical coordinates $(\bar{\omega},\phi,z)$, a necessary condition for stability, for sufficiently large χ/η, is given by $-g_z(\partial/\partial z)\ln(B_\phi/\rho) > 0$ and $[-g_{\bar{\omega}} - (2c^2/\bar{\omega})](\partial/\partial\bar{\omega})\ln(B_\phi/\rho\bar{\omega}) > 0$, where χ is the thermal diffusivity, η the magnetic diffusivity, g the gravitational acceleration, ρ the density, and c^2 the isothermal sound speed. Since g_z is negative or positive according as z is positive or negative, B_ϕ/ρ must be an increasing function of z for positive z and an increasing function of $-z$ for negative z, in order to ensure stability. In those regions of the star where $|g_{\bar{\omega}}| > 2c^2/\bar{\omega}$, $B_\phi/\rho\bar{\omega}$ will have to be an increasing function of $\bar{\omega}$ for the configuration to be stable. Where $|g_{\bar{\omega}}| < 2c^2/\bar{\omega}$, stability will require $B_\phi/\rho\bar{\omega}$ to decrease with increasing $\bar{\omega}$. In the absence of a gravitational field, stability requires that $(\partial/\partial z)\ln(B_\phi/\rho) = 0$ and $-(\partial/\partial\bar{\omega})\ln(B_\phi/\rho\bar{\omega}) > 0$ (with no restriction on the magnitude of χ/η). Stability criteria are also presented for several interesting limiting situations, e.g., the adiabatic one, $\chi = \eta = 0$. Even though a magnetic field configuration may be stable to adiabatic perturbations, the non-zero thermal conductivity of the medium may promote an instability. Such a diffusive instability is studied in detail. Gravitational potential energy, which under adiabatic conditions normally provides a stabilizing influence (Schwarzschild's stability criterion), can reverse its role and be the source of the magnetic instability. (auth)

21812 RAPIDLY ROTATING STARS. II. MASSIVE WHITE DWARFS. Ostriker, Jeremiah P.; Bodenheimer, Peter (Princeton Univ., N. J.). Astrophys. J., 151: 1089-98(Mar. 1968).

Equilibrium models of axisymmetric, zero-temperature stars in differential rotation, representing possible final states of stellar evolution, are presented in detail for the mass range 1.3 to 4.1 $M_\odot$. Total angular momenta of the computed models are in agreement with those estimated from observations of main-sequence stars of the corresponding masses. Physical effects which limit the range of validity of the models, including viscosity and the occurrence of dynamical instabilities, are briefly discussed. (auth)

21813 RAPIDLY ROTATING STARS. I. THE SELF-CONSISTENT-FIELD METHOD. Ostriker, Jeremiah P.; Mark, James W-K. (Princeton Univ., N. J.). Astrophys. J., 151: 1075-88(Mar. 1968).

A method is described by which one can determine the equilibrium structure of a star having kinetic energy of rotation comparable to its gravitational energy. It is assumed that the inertial forces are conservative and that the star remains axially symmetrical. An iterative procedure is outlined by which the density distribution can be found which will be in equilibrium with the potential field derived from that density distribution. In the present paper the potential theory aspect of this problem is emphasized. (auth)

21814 EFFECT OF ROTATION ON RADIATION FROM STARS. I. PROPERTIES OF THE CONTINUUM. Hardorp, J.; Strittmatter, P. A. (Univ. of California, San Diego, La Jolla). Astrophys. J., 151: 1057-73(Mar. 1968).

Using a uniform series of interior models, the effect of rigid body rotation on the continuum radiation from homogeneous main-sequence stars in the mass range 1.5 to 8 $M_\odot$ is calculated. Continuous energy distributions in the range 1350 to 10,000 Å are listed for various rotational velocities and directions of observation. Results are shown to be in qualitative agreement with the available observational evidence though the predicted effects are, in general, found to be too small. For these models, the maximum spread in the main sequence is found to be ≈0.7 mag at a given color; the importance of the rotational spread in the two-color diagram and in a plot of $c_1 - (b - y)$ is also discussed. (auth)

21815 INTRINSIC POLARIZATION OF RAPIDLY ROTATING EARLY-TYPE STARS. Harrington, J. Patrick; Collins II, George W. (Ohio State Univ., Columbus, Ohio Wesleyan Univ., Delaware). Astrophys. J., 151: 1051-6(Mar. 1968).

Chandrasekhar pointed out that radiation emerging from a plane-parallel semi-infinite pure-scattering atmosphere will be partially polarized. This fact combined with the gravity darkening, the rotational distortion, and the dominance of electron scattering in early-type stars should lead to some intrinsic polarization. The polarization present in such stars is calculated as a function of their rotational velocity and angle of inclination. It is demonstrated that one may have a degree polarization as high as 1.70% (0.037 mag) for stars rotating at the limit of stability. Several suggestions are presented for detecting this effect in real stars. (auth)

21816 STELLAR ROTATION IN THE SCORPIO–CENTAURUS ASSOCIATION. Slettebak, Arne (Ohio State Univ., Columbus, Ohio Wesleyan Univ., Delaware). Astrophys. J., 151: 1043-50 (Mar. 1968).

Spectral types and rotational velocities were estimated for 82 members of the Scorpio–Centaurus association. The more luminous stars (essentially B0–B6) in the association as a whole appear to rotate somewhat more slowly than field stars of corresponding type, but there is evidence that stellar rotation in the denser Upper Scorpius portion of the association is greater than in the outlying regions. The less luminous stars (B7–A0) have a mean rotational velocity which is appreciably larger than for a sample of field stars of corresponding type. (auth)

21817 SPECTRAL-LINE FORMATION IN INHOMOGENEOUS ATMOSPHERES. Wilson, P. R. (Univ. of Colorado, Boulder). Astrophys. J., 151: 1029-41(Mar. 1968).

A method is presented for solving the three-dimensional Eddington approximation of the radiative transfer equation for the spectral line formed by a two-level atom in an atmosphere exhibiting horizontal fluctuations in its physical properties. The method is demonstrated in two simple cases in which (i) the electron temperature is assumed to fluctuate sinusoidally in one direction parallel with the surface, and (ii) similar fluctuations are postulated for the density. Criteria for the stability of the solution and for assessing the accuracy of the results are discussed. In case (i) the opacity is arbitrarily assumed to be constant, since accurate methods are available for the solution of problems of this type, and the accurate and approximate solutions are compared. It is found that, although the source function fluctuations below the surface are comparable in each case, the computed emergent intensity fluctuations are much greater in case (i) than in case (ii) where the opacity fluctuations greatly reduce the effect of the source function fluctuations. (auth)

21818 THREE-DIMENSIONAL FORM OF THE EDDINGTON APPROXIMATION. Wilson, P. R. (Univ. of Colorado, Boulder). Astrophys. J., 151: 1019-28(Mar. 1968).

Derivations of the three-dimensional form of the Eddington approximation by Giovanelli and by Unno and Spiegel are exam-

ined and shown to be equivalent. They are compared with an earlier form obtained by Chandrasekhar for stellar interiors and shown to be superior near the surface. A third derivation is given which permits one to obtain a mathematically consistent boundary condition for zero incident flux on a plane surface. This is similar to Krook's boundary condition for the one-dimensional problem. This derivation also permits the investigation of the accuracy of this approximation in a three-dimensional atmosphere. While in general agreement with Unno and Spiegel's claims for the value of the approximation in astrophysical investigation, this paper disagrees with their general conclusions for optically thin atmospheres and discusses several examples where errors are found. Finally, the importance of the three-dimensional approximation is emphasized in applications to atmospheres in which both intensity and opacity fluctuate generally. (auth)

21819 ATMOSPHERIC PARAMETERS FOR RU CAM DURING ITS RECENT QUIESCENT PHASE. Wallerstein, George (Univ. of Washington, Seattle). Astrophys. J., 151: 1011-17 (Mar. 1968).

Two spectrograms of RU Cam were taken during January 1965, after the star had ceased varying. A curve-of-growth analysis of the atomic lines using ϵ Virginis as a standard star yields a normal ratio of iron to hydrogen and an electron pressure that is lower than that in ϵ Vir by a factor of 10. A discussion of the abundances leads to the suggestion that about one-half of the material presently in the atmosphere of RU Cam has been processed through partial helium burning and subsequent carbon cycling before being mixed to the surface. From the electron pressure a relation between mass and absolute magnitude is derived. Limits on the mass and absolute magnitude of RU Cam are established by considering the height above the galactic plane, the pulsation constant Q, and the range of temperature variation when it was varying. The mass probably lies between 0.5 and 2.0 $M_\odot$ and the absolute visual magnitude is within the limits -2.0 and -3.5. The cause of the cessation of pulsation is not apparent. (auth)

21820 LOCATION OF A FEW SUBDWARFS IN THE THEORETICAL H–R DIAGRAM AND THE HELIUM CONTENT OF POPULATION II. Cayrel, Roger (Inst. for Advanced Study, Princeton, N. J.). Astrophys. J., 151: 997-1010(Mar. 1968).

It is shown that photometric systems in which the line blocking is small enough to be accurately determined, like the GRI colors of Stebbins and Whitford, the vby colors of Strömgren, or the VRIJK colors of Johnson offer a more reliable way to obtain the effective temperature of subdwarfs than the UBV system. From the available data on these different systems, it is established that the main sequence of extreme subdwarfs, late enough to be unevolved, is below the main sequence of nonmetal-poor stars by an amount of 0.7 ± 0.3 mag. The conclusion that extreme subdwarfs have a normal helium-to-hydrogen ratio seems unavoidable. Mild subdwarfs do not show any clear segregation from Population I, except perhaps μ Cassiopeiae. It is suggested that the smaller effect which should be observed for those stars is nearly cancelled by a residual evolution effect. (auth)

21821 EFFECTIVE TEMPERATURES OF THE CENTRAL STARS OF PLANETARY NEBULAE. Capriotti, Eugene R.; Kovach, William S. (Ohio State Univ., Columbus. Ohio Wesleyan Univ., Delaware). Astrophys. J., 151: 991-5(Mar. 1968).

The effective temperatures of the central stars of thirty-five planetary nebulae were determined on the assumption that the central stars are non-gray and that there is complete absorption in the He^+ Lyman continuum in each case. The model atmospheres of Böhm and Deinzer that correspond to the Harman and Seaton sequences of stars with masses between 0.5 and 1 solar mass are assumed to be representative of the atmospheres of the central stars of planetary nebulae. Upper and lower limits were set to the characteristic optical thickness at the Lyman limit in the H^0 continuum for each object under consideration. (auth)

21822 INFRARED EXCESSES IN T TAURI STARS AND RELATED OBJECTS. Mendoza, Eugenio E. (Univ. Nacional de Mexico, Mexico City. Univ. of Arizona, Tucson). Astrophys. J., 151: 977-89(Mar. 1968).

Multicolor photometric observations were made, over the range of wavelength from 0.36 μ in the ultraviolet to 5.0 μ in the infrared, on thirty-three T Tauri-like stars. This photometry confirms the infrared excess previously reported. It also shows irregular light variations in all UBVRIJHKLM bands. Most of the infrared excesses in these stars remain after correction for interstellar extinction. The corrected photometry, converted into fluxes, was used to compute total luminosities; they range from 4.9 to 828 times the solar luminosity. These luminosities, combined with the adopted effective temperatures, are used to estimate masses and ages. The former range from 1.8 to 7.3 $M_\odot$; the latter range from 16,000 to 3.9×10^6 years. The luminosities and effective temperatures are also used to construct the H–R diagram for T Tauri-like stars. They lie well above the main sequence. The infrared excesses can be explained by two models. If the infrared luminosity is many times the visual luminosity, then a thick circumstellar dust cloud absorbs the visual radiation and reradiates in the infrared the energy produced by the parent star. If the infrared luminosity is a few times the visual luminosity, then the infrared excess is the result of the heating of the outer stellar wind by the absorption of the stellar cosmic rays. (auth)

21823 HYDROMAGNETIC SHOCK WAVES AND THEIR INFRARED EMISSION IN H I REGIONS. Field, George B. (Univ. of California, Berkeley); Rather, J. D. G.; Aannestad, P. A.; Orszag, S. A. Astrophys. J., 151: 953-75(Mar. 1968).

The steady-state equations for shocks with Mach numbers 5, 10, 15, and 20 (4 to 16 km/sec) are solved, including a magnetic field between 0 and 10^{-6} gauss parallel to the shock front. The structure of the shock is calculated, taking into account cooling mechanisms that are effective in H(I) regions, such as collisions of H atoms with O atoms and C^+, Si^+, and Fe^+ ions. Electron collisions with ions are also included, as are collisions of H atoms with H_2 molecules. Collisional excitation of fine-structure and rotational levels results in an infrared emission spectrum of twelve lines, whose intensities are calculated for various H_2/H ratios between 10^{-6} and 10^{-1}. Cooling times for the gas to return to its preshock temperature (100°K) are evaluated, and are in the range 5 to 15×10^3 years for $H_2/H < 10^{-3}$. Even shorter times are found for $H_2/H > 10^{-3}$. The very short cooling times are largely due to collisions of H atoms with O atoms. They mean that shock waves generated by cloud collisions or by expanding H(II) regions behave much like isothermal shocks. Two rotational lines of H_2, 8 μ ($J = 6 \rightarrow 4$) and 12 μ ($J = 4 \rightarrow 2$), are emitted with considerable intensity. They may be observable by ground-based instruments if H_2/H is large enough. (auth)

21824 ELECTRON DENSITIES IN FOUR H II REGIONS FROM 4-CM OBSERVATIONS. Cunningham, A. A. (Univ. of California, Berkeley). Astrophys. J., 151: 945-52(Mar. 1968).

Observations of NGC 6523, NGC 6611, NGC 7000, and IC 410 were made with the University of California 85-foot radio telescope at a wavelength of 4 cm. Using spherical models, one-dimensional rms electron density distributions were computed at an electron temperature of 8000°K. From these density profiles, and assuming that a systematic expansion exists, ages of these diffuse nebulae were estimated. These ages are considerably shorter than the element-burning lifetimes of the exciting stars. (auth)

21825 PHYSICAL ADSORPTION PROCESSES ON INTERSTELLAR GRAPHITE GRAINS. Williams, David A. (Goddard Space Flight Center, Greenbelt, Md.). Astrophys. J., 151: 935-43(Mar. 1968).

The conditions are examined under which mantles will form on interstellar graphite grains. They may form by the adsorption of molecules from the interstellar gas, and relations are given connecting the gas densities and grain temperatures for which mantle growth occurs. Graphite grains in quiescent H(I) regions will not grow mantles unless the grain temperature is less than about 20°K. In the atmospheres of cool stars where the molecule density is expected to be high, grains blown out of the atmosphere by radiation pressure have even higher temperatures and mantle growth is prevented until the interstellar case prevails. Physically adsorbed atoms form quasimolecules on the grains' surfaces which can interact with the lattice to form stable molecules if these resultant molecules have dipole moments on the order of a debye. (auth)

21826 NORMAL OH EMISSION AND INTERSTELLAR DUST CLOUDS. Heiles, Carl E. (Univ. of California, Berkeley). Astrophys. J., 151: 919-34(Mar. 1968).

Normal emission from OH in interstellar dust clouds has been detected. The clouds have normal cosmic abundances; the hydrogen, which is not observed to emit 21-cm line radiation, is probably all H_2. The amounts of OH and H_2 are consistent with statistical equilibrium with known reactions. The clouds are sufficiently opaque to exclude nearly all of the galactic radiation field so that photodissociation does not occur; also, the resulting radiation pressure differential helps hold the clouds together. (auth)

21827 POLARIMETRIC OBSERVATIONS OF NEARBY STARS IN THE DIRECTIONS OF THE GALACTIC POLES AND THE GALACTIC PLANE. Appenzeller, I. (Univ. of Chicago). Astrophys. J., 151: 907-18(Mar. 1968).

Polarimetric observations for 308 stars were obtained with the rotatable telescope of the Yerkes Observatory. With few exceptions all stars are within 200 pc of the Sun. The position angles of the observed polarization indicate systematic differences in the direction of the interstellar magnetic field, even within 100 pc of the Sun. The galactic longitude of the direction of the magnetic field

observed at the two galactic poles was found to be different by 19° ± 4°. (auth)

21828 HOMOGENEOUS COSMOLOGICAL MODELS WITH BOUNDED POTENTIAL. Edelen, Dominic G. B.; Wilson, Albert G. (Douglas Advanced Research Labs., Huntington Beach, Calif.). Astrophys. J., 151: 1171-7(Mar. 1968).

Under the assumption that there exists a finite global upper bound to the gravitational potential, $2Gm/c^2r$, it is shown that simply connected homogeneous models based on the Walker–Robertson line element must have zero mean density if the curvature parameter k is 0 or −1. For homogeneous models with k = +1, all global potential bounds less than or equal to the Schwarzschild limit imply a positive cosmological constant. If the potential is globally less than 0.912 (spherical space) or 0.75 (elliptical space), and if the physically realizable pressures are at all future epochs bounded below by zero and above by photon gas pressure, $\rho c^2/3$, k = +1 models will expand monotonically without limit—for all future time. Asymptotic values for large times are in the usual notations: $H = c\sqrt{(\lambda/3)}$, q = −1, p = 0, and ρ = 0. Under the same conditions, the present value of the deceleration parameter is less than −1, so that the asymptotic value is approached from below. The cosmological constant is bounded below by $3H_0^2/c^2$, where H_0 is the present value of the Hubble parameter. (auth)

21829 TWO-FLUID MODEL OF THE SOLAR WIND. Hartle, R. E.; Sturrock, P. A. (Ames Research Center, Moffett Field, Calif.). Astrophys. J., 151: 1155-70(Mar. 1968).

This theoretical study of the solar wind takes account of the fact that the collisional energy-exchange rate between electrons and protons is sufficiently slow that the electrons and protons can have quite different temperatures. The basic equations comprise a continuity equation, an equation of motion, and two heat equations, one for each species—electrons and protons. Each heat equation takes account of thermal conductivity in that species and energy exchange with the other species. In order to determine the region of applicability of these fluid-type equations, the electron–electron, and proton–proton energy/momentum relaxation rates are compared with the local expansion rate. These comparisons indicate that, for the model investigated, the use of fluid equations is justifiable out to about 10^3 R⊙. (auth)

21830 RECOMBINATION FRONTS IN STELLAR-WIND FLOWS. Newman, R. C.; Axford, W. I. (Cornell Univ., Ithaca, N. Y.). Astrophys. J., 151: 1145-54(Mar. 1968).

A simplified model of a stellar wind is examined in which recombination of the ionized hydrogen is taken into account. The gas is assumed to recombine in a shell (recombination front) the thickness of which is small compared with the radius of the H(II) region. The flow in the H(II) region is taken to be isothermal and that in the H(I) region to be adiabatic. Allowed transitions in the flow variables as a function of the Mach number just inside the H(II) region are obtained by an examination of the structure of recombination fronts, and a set of complete solutions corresponding to $T_* = 40{,}000°K$ are presented. The model may have application to non-expanding planetary nebulae. (auth)

21831 COMMENTS ON THE CALCULATED H_γ PROFILES OF SEARLE AND OKE. Krishna Swamy, K. S. (Goddard Space Flight Center, Greenbelt, Md.). Astrophys. J. 151: 1195-7(Mar. 1968).

It is shown that the Searle and Oke H_γ profiles give effective temperatures which are high for stars like the Sun. (auth)

21832 EVOLUTIONARY INTERPRETATION OF Of STARS. van den Bergh, Sidney (Univ. of Toronto). Astrophys. J., 151: 1191-3(Mar. 1968).

It is shown that Of stars occur much less frequently in HII regions and in clusters than do normal O-type stars. The implication of this observation is that Of stars of a given spectral type are older and hence presumably more highly evolved than are absorption-line O stars of the same spectral type. (auth)

21833 CLASS OF A MODEL OF THE UNIVERSE WITH MAGNETIC FIELD. Smaranda, D. (Faculte de Mathematique et Mecanique, Bucharest). Bull. Soc. Roy. Sci. Liege, 36: 431-42 (1967). (In French).

The semi-closed magnetic model of the Universe is considered and it is shown that this model is, for any X(t) and Y(t), at most of class 2. The imbedding formulae are given for this case. (auth)

21834 RADIATION AND PHYSICAL PROPERTIES OF THE M87 JET. Felten, James E. (Univ. of California, San Diego, La Jolla). Astrophys. J., 151: 861-79(Mar. 1968).

Existing observations of the jet in the radio galaxy M87 are reviewed and compared with the consequences of various theories as to its physical structure. Many observational uncertainties remain, even in the optical band. If the optical electrons are produced at the nucleus and escape outward to the end of the jet, the ambient plasma must also move outward with mass velocity ~c; streaming instabilities and the short lifetimes of the fast electrons preclude the possibility that they move in a stationary plasma. Production of secondary electrons by a large proton flux provides a tenable model; the age of such a jet is $\sim 10^5$ years, and a plasma density ~200 cm^{-3} is sufficient to maintain it this long against the internal cosmic-ray pressure. The equipartition field is $\sim 10^{-2}$ gauss. If the recently observed x rays are shown to be an extension of the synchrotron spectrum, this model will conflict with upper limits on production of gamma rays (10^{13} eV) in M87 set by searches for Cerenkov light from air showers. Local acceleration of optical electrons by plasma processes in the jet remains a strong possibility. Fermi statistical acceleration, however, is not promising; it is augmented by turbulence but still requires random velocities ≳3000 km/sec and fields $\lesssim 3 \times 10^{-6}$ gauss. Adequate theories of plasma acceleration are lacking. If x-ray electrons are produced as secondaries or accelerated locally over much of the lifetime of a radio galaxy, the diffuse x-ray background may be due to such sources. They should also produce optical synchrotron radiation. (auth)

21835 STELLAR CONTENT AND DISTANCE OF THE GALAXY NGC 2403 IN THE M81 GROUP. Tammann, G. A.; Sandage, Allan (Carnegie Institution of Washington, D. C. California Inst. of Tech., Pasadena). Astrophys. J., 151: 825-60(Mar. 1968).

Fifty-nine variables were found in the nearby Sc galaxy NGC 2403, which is a member of the M81 group. Of these, seventeen are Cepheids ranging in period from $^d7.48$ to $^d20.230$; eight are very bright irregular blue variables of the type previously found in M31 and M33; seventeen are bright, red irregular supergiant variables similar to those in h and χ Per; there is one eclipsing binary; and sixteen are unclassified variables of undetermined nature. NGC 2403 is the first galaxy outside the Local Group in which Cepheids have been detected. Light curves were determined relative to a photoelectric sequence of seventy-three stars which covers the interval from B = 9.15 to B = 22.70, V = 8.39 to V = 21.80. Three-color photoelectric observations of the sequence stars brighter than V = 19.5 show that the local reddening due to the galactic system is E(B−V) = 0.06 mag. The period–luminosity relations for Cepheids in B and V at maximum light provide two well-determined upper envelope fits to the standard P–L function, giving apparent distance moduli of NGC 2403 of $(m-M)_{AB} = 27.80 \pm 0.1$ and $(m-M)_{AV} = 27.75 \pm 0.1$. These reduce to true moduli of $(m-M)_{0,B} = 27.56$, and $(m-M)_{0,V} = 27.57$ from the Cepheids alone. One unexpected result is that the red supergiants, both constant and variable, may be a new and precise distance indicator. There appears to be an upper envelope to the absolute luminosity of these stars at about $M_V = -8.0$. Such red stars can be located with ease in all Sc and Irr galaxies with $(m-M)_{AV} < 29$ by comparing red and blue plates and, therefore, they can be important in an intermediate step for the redetermination of the Hubble constant. The ratio of mean redshift of the M81 group—each galaxy corrected individually for solar motion—to the distance to NGC 2403 of r = (3.25 ± 0.20) × 10^6 pc is v/r = (65 ± 15) km sec^{-1} Mpc^{-1}. This is not claimed to have any relation to the Hubble constant because the sample contains only one group, but similar analysis of many additional groups may eventually lead to an adequate value of H. (auth)

21836 SEARCH FOR FRACTIONALLY CHARGED PARTICLES IN THE SOLAR PHOTOSPHERE. Leacock, R. A.; Beavers, W. I.; Daub, C. T. (Ames Lab., Iowa). Astrophys. J., 151: 1179-86(Mar. 1968). (IS-1626).

The fractionally charged particles, called quarks, proposed by Gell-Mann and Zweig to explain regularities in the meson–baryon particle spectrum observed in high-energy collision experiments are so far experimentally undetected. Reported here are the results of a search of the solar spectral data for evidence of quark atoms, i.e., hydrogenic atoms formed of one +⅔e quark and one electron, in the photosphere. Ultraviolet and infrared spectral tables are searched for quark Lyman and Balmer series, for fine-structure splitting of quark Balmer-a, and for correspondences between quark Lyman-a and quark Balmer-a. Although three possible quark Lyman series are observed, the general conclusion of this investigation is that there is no clear evidence for the presence of quark atoms in the solar photosphere. An upper limit of 10^{-9} for quark atom photospheric abundance relative to hydrogen is obtained. (auth)

21837 ELECTRON–ION BREMSSTRAHLUNG FROM AN EXTREME RELATIVISTIC PLASMA. Quigg, Chris (Univ. of California, Livermore). Astrophys. J., 151: 1187-9(Mar. 1968). (UCRL-70606).

The spectrum and rate of energy loss from electron–ion brems-

strahlung are calculated for a Maxwell–Boltzmann plasma in the extreme relativistic limit. (auth)

21838 HIGH-TEMPERATURE EQUATION OF STATE BASED ON THE THOMAS–FERMI AND CONTINUUM HYDROGENIC ATOMIC MODELS. Vulliet, W. G.; Smith, P. R. (General Atomic Div., General Dynamics Corp., San Diego, Calif.). Astrophys. J., 151: 1137-43(Mar. 1968).

A simple analytic method is developed for calculating the electronic contribution to the energy and pressure of elements and mixtures of elements. Two atomic models and statistics are used in the method: (1) a hydrogenic model with continuous energy levels using Maxwell–Boltzmann statistics and (2) a zero-temperature Thomas–Fermi model using Fermi–Dirac statistics. The equations of state computed from the two models are combined in a simple manner which is dependent on the free-electron degeneracy parameter. The results agree within a few per cent with Latter's exact numerical solution, except at low temperatures and high densities (kT < 1 eV) due to the neglect, in this paper, of the influence of the free electrons on the ionization potential. This is, however, not of much practical importance since the electronic contribution to the equation of state is insignificant in that region. (auth)

21839 NUCLEUS OF THE SEYFERT GALAXY NGC 4151. Oke, J. B.; Sargent, Wallace L. W. (Carnegie Inst. of Washington, D. C. California Inst. of Tech., Pasadena). Astrophys. J., 151: 807-23(Mar. 1968).

The optical and near-infrared spectrum of the nucleus of NGC 4151 was studied. The observations consist of photographic spectrograms covering the wavelength range λλ3500 to 6800 and photoelectric measurements of the continuous energy distribution and emission-line strengths in the range λλ3300 to 11000. It is inferred that the emission lines arise in at least two physically distinct regions. First there is a region, having $N_e \sim 5000$ cm^{-3}, $T_e \sim 20000$°K, and a mass of about 2×10^5 M⊙, which gives rise to the main emission-line spectrum. This component fills only about 1/40 of the total volume of the nucleus, 50 pc in diameter, and appears to be in the form of clouds or filaments in relative motion with velocities of about 450 km/sec. This gas is probably ionized and heated by degradation of the mass motions. It is likely that the difference in line profile between permitted and forbidden lines is due to electron scattering. Second, there is a region which gives rise to coronal lines of [Fe X] and [Fe XIV] discovered by O. C. Wilson. The temperature of this gas is about 10^6°K, but N cannot be determined directly from the spectrum. However, the adopted value of $N_e = 100$ cm^{-3} would both fill the whole volume of the nucleus and also keep this hot gas in pressure equilibrium with the cool clouds. The mass of the coronal gas is $\leq 10^5$ M⊙. The recombination radiation from these two regions cannot account for the observed optical continuum. There are no stellar absorption features in the continuous spectrum of the nucleus which must, therefore, be partly non-thermal. NGC 4151 is only a weak radio source, and ways of producing a non-thermal optical continuum while suppressing radio-frequency synchrotron radiation are considered. Free–free absorption and possibly the Tsytovich effect appear able to attenuate radio frequencies below a few GHz. It is estimated that energy must be continuously supplied to generate the mass motions in the nucleus, rather than a single explosive event. (auth)

Atomic and Molecular Physics

Refer also to abstracts 21397, 21398, 21838, 22200, 22375, and 22647.

21840 (AED-C–12-16-I) BIBLIOGRAPHIEN ZUR KERNFORSCHUNG UND KERNTECHNIK. SEKTION 12. OSTLITERATUR DER KERNWISSENSCHAFTEN. NUMMER 16. ATOM- UND MOLEKULARPHYSIK. (Bibliographies in Nuclear Science and Technology. Section 12. Nuclear Science Literature of Eastern Countries. Number 16. Atomic and Molecular Physics). Ensslen, Benno (comp.) (Zentralstelle fuer Atomkernenergie-Dokumentation, Frankfurt am Main (West Germany)). Jan. 1968. 191p. (In German and English). Dep.

A listing is presented of 761 articles on various aspects of atomic and molecular physics. (M.O.W.)

21841 (AED-C–12-16-II) BIBLIOGRAPHIEN ZUR KERNFORSCHUNG UND KERNTECHNIK. SEKTION 12. OSTLITERATUR DER KERNWISSENSCHAFTEN. NUMMER 16. ATOM- UND MOLEKULARPHYSIK. (Bibliographies in Nuclear Science and Technology. Section 12. Nuclear Science Literature of Eastern Countries. Number 16. Atomic and Molecular Physics). Ensslen, Benno (comp.) (Zentralstelle fuer Atomkernenergie-Dokumentation, Frankfurt am Main (West Germany)). Jan. 1968. 156p. (In German and English). Dep.

A listing is presented of 629 papers on various aspects of molecular physics. (M.O.W.)

21842 (AERE-M–1708) DE-ACTIVATION OF AN EXCITED ATOM AT A GRAPHITE SURFACE. Burke, P. G.; Tait, J. H. (Atomic Energy Research Establishment, Harwell (England)). Jan. 1966. 8p. Dep. CFSTI. UK.

An order of magnitude estimates is made of the probability that an excited oxygen atom is deactivated on a collision with a graphite surface and is found to be greater than 0.1. The implications of this result in the study of the radiolysis of carbon dioxide in the pores of a graphite moderator are discussed. (auth) (UK)

21843 (NYO–2962-6, pp 20-9) PAULI EXCITATION OF NEON ATOMS DURING COLLISIONS. Brandt, W.; Laubert, R. (New York Univ., N. Y. Radiation and Solid State Lab.).

High-purity foils of Al and Mg were bombarded with 100- to 200-keV neon ions and the resulting x-ray spectra were recorded. The main x-ray peak in both materials had an energy of 0.85 ± 0.03 keV, which corresponds to Ne(K) x rays. It is concluded that the Ne(K) x rays result both from collisions of Ne ions with metal atoms and from collisions with retained Ne atoms. X-ray-production cross sections are calculated for Al and Ne atoms. A mechanism referred to as the Pauli excitation of electrons in atomic collisions is suggested to explain the cross sections obtained, which are larger than those calculated from presently available theories. (A.G.W.)

21844 (NYO–2962-6, pp 30-5) STOPPING POWER. Brandt, W.; Laubert, R. (New York Univ., N. Y. Radiation and Solid State Lab.).

A new method of measuring the stopping power of materials utilizes the production of characteristic x rays when a target is bombarded by swift heavy particles. Layers of various thicknessess of the material of interest are deposited on a suitable substrate. X-ray yields are measured from bombardment of a thick layer, a thin layer, and the substrate, and stopping powers are calculated. Results are shown for helium ions and protons on aluminum and protons on copper. (A.G.W.)

21845 (NYO–2962-6, pp 63-9) CHARGE EXCHANGE IN PROTON–ALKALI METAL COLLISIONS. Sellin, I. A.; Granoff, L. (New York Univ., N. Y. Radiation and Solid State Lab.).

Charge transfer cross sections for collisions of protons with vapors of cesium, potassium, and rubidium were measured in the energy range up to 50 keV. Data for all three metals followed generally the same trend. Results are compared with results of other investigators. (A.G.W.)

21846 (ORO–3557-3) PROTON SPUTTERING OF POLYCRYSTALLINE GOLD. Finfgeld, Charles R. (Roanoke Coll., Salem, Va. Dept. of Physics). Nov. 1967. Contract AT(40-1)-3557. 65p. Dep. CFSTI.

Thesis. Submitted to Virginia Polytechnic Inst., Blacksburg.

An experiment to determine the yield and angular distribution for sputtering of polycrystalline gold by normally incident protons of energies between 500 eV and 8 keV has been performed. An ion source system delivering a magnetically analyzed proton beam of 1 mA/cm^2 current density to a target at a pressure of 5×10^{-6} torr was utilized. Measurement of the integrated proton current, with correction for secondary electron emission, and determination of the quantities of sputtered gold by neutron activation established the yields. Autoradiographs of the sputtered deposits were used to study the angular distribution. The gold targets, consisting of microcrystals with preferred orientation, were sputtered predominantly on (100) and (110) planes, and the yields were not observed to depend perceptibly on the crystal orientation. The yield was a maximum of 0.014 atoms/proton at a proton energy of 4 to 5 keV, dropping off gradually at higher energies and sharply at lower ones. Analysis of the sputtered deposit spot patterns indicated that focused collision sequences were of greater importance in prcton sputtering than in sputtering by heavier ions. Significantly, a readily detectable yield for sputtering by 500-eV protons, which could transfer at most 10 eV to gold atoms in the target, suggests a new, lower sputtering threshold for gold. (auth)

21847 (TID–24331, pp 15-21) ATOMIC RESONANCE AND SCATTERING. (Massachusetts Inst. of Tech., Cambridge. Research Lab. of Electronics).

Spin-dependent interactions in atomic systems are theoretically studied. The collision between two single-electron atoms is discussed in particular. (M.O.W.)

21848 CALCULATION OF ATOMIC WAVE FUNCTIONS. Mayers, D. F. (Oxford Univ.); O'Brien, F. J. Phys., B, 1: 145-50(Mar. 1968).

The numerical method used on a general programme for the solution of the Hartree–Fock equations in the calculation of radial wave functions for atomic configurations is described. Calculations were made on a number of atoms and ions of astrophysical interest of atomic number up to 56. (auth) (UK)

21849 TEMPERATURE DEPENDENCE OF THE $NO^+ + e$ DISSOCIATIVE–RECOMBINATION-RATE COEFFICIENT. Hansen, C. Frederick (Ames Research Center, Moffett Field, Calif.). Phys. Fluids, 11: 904-6(Apr. 1968).

If constant transition probability at the N + O and NO^+ potential crossing is assumed, the $NO^+ + e$ recombination rate is shown to vary from a $T^{-\frac{1}{2}}$ to $T^{-\frac{1}{2}}$ dependence as T increases. This result is found consistent with most of the experimental evidence. (auth)

21850 STOPPING CROSS-SECTION MEASUREMENTS IN CARBON USING RECOIL IONS FROM RADIOACTIVE DECAY. Poole, D. H.; Warner, A. G.; Hancock, R.; Woolley, R. L. (Central Electricity Generating Board, Berkeley, Eng.). J. Phys., D, 1: 309-12(Mar. 1968).

An experiment is described for measuring the stopping cross section of fast heavy ions colliding with stationary atoms. The heavy ions are obtained by recoil from alpha disintegration, and their energy loss in passing through thin absorber foils is measured by a time-of-flight method. Using this technique the mean stopping cross section of 169-keV lead ions in carbon was shown to have the value 32.7×10^{-14} eV cm^2 (±5%). (auth) (UK)

21851 MEASUREMENT OF THE ASSOCIATIVE IONIZATION CROSS SECTION OF MERCURY VAPOUR. Tan, K. L.; Von Engel, A. (Oxford Univ.). J. Phys., D, 1: 258-62(Feb. 1968).

As a result of collisions between excited Hg atoms in the $^3P_1$ and $^3P_0$ states, positive molecular ions Hg_2^+ and electrons are produced. From the observed saturation currents the associative ionization cross section is found to be about 5×10^{-14} cm^2, which compares favourably with theoretical estimates. Using this result the cross section for the reverse process, dissociative recombination into excited atoms, was determined thermodynamically. The recombination coefficient agrees with that found in earlier experiments in a decaying Hg plasma. (auth) (UK)

21852 IMPACT PARAMETER TREATMENT OF ATOMIC COLLISIONS. McCarroll, R.; Salin, A. (Observatoire de Paris). J. Phys., B, 1: 163-71(Mar. 1968).

A generalized impact parameter formalism for heavy-particle collisions is developed in a rigorous way from a purely quantal formalism in which all quantities that tend uniformly to a limit as the mass of the atomic nuclei becomes infinite are replaced by that limit. An expression for the differential scattering cross section is derived in terms of quantities obtained from impact parameter calculations. This expression is used to calculate the probability of charge exchange at large angles of scattering for protons in hydrogen. It is shown that the formalism predicts the correct damping of the oscillations in the probability at low impact energies. (auth) (UK)

21853 HIGH-ENERGY BEHAVIOUR OF ELECTRON CAPTURE CROSS SECTIONS. Coleman, J. P. (Univ. of Durham, Eng.). J. Phys., B, 1: 315-17(Mar. 1968).

It is shown that, contrary to the view expressed in their paper, the work of McCarroll and Salin does not constitute a derivation of the exact asymptotic energy dependence of the cross section for resonant electron capture by protons from atomic hydrogen. (auth) (UK)

21854 ELECTRON CAPTURE INTO EXCITED STATES IN THE IMPULSE APPROXIMATION. Coleman, J. P.; Trelease, S. (Univ. of Durham, Eng.). J. Phys., B, 1: 172-80(Mar. 1968).

Impulse approximation cross sections are evaluated for the electron capture processes $H^+ + H(1s) \rightarrow H(2p, 3s \text{ or } 3p) + H^+$ and $He^{2+} + H(1s) \rightarrow He^+ (2p \text{ or } 3s) + H^+$. The results for capture into the 2p state of atomic hydrogen are in close agreement with the measurements of Stebbings et al. in 1965. Total impulse approximation cross sections for capture by protons and alpha particles are estimated. The proton impact cross sections are practically identical with estimates by Coleman and McDowell (1965) based on less reliable data. (auth) (UK)

21855 PERIODIC FEATURES OF THE STATISTICAL ATOM WITH EXCHANGE AND CORRELATION. Auluck, F. C.; Jain, Ashok; Kumar, Satish (Univ. of Delhi). Can. J. Phys., 46: 1-13 (Jan. 1, 1968).

The periodic features of atoms are studied using a statistical model embellished with exchange and correlation. It is shown that the earlier results, obtained on the basis of the simple TF model, can be computed in an analytic form by using the Tietz approximation. Single-particle energy levels of neutral atoms are calculated. A new angular momentum assignment is proposed and is shown to give values of $\nu(l, Z)$ (the number of electrons with orbital angular momentum quantum number l, in an atom of atomic Z) which are in very close agreement with the empirical values. The relativistic mass–velocity correction is incorporated in the calculation of angular-momentum groups. Finally, some suggestions are made for improving the present formalism. (auth)

21856 TRIAL OF A NUMERICAL METHOD FOR SOLVING THE SCHROEDINGER WAVE EQUATION IN SEVERAL VARIABLES. Bassett, I. M. (Univ. of Sydney). Aust. J. Phys., 21: 113-19(Apr. 1968).

A numerical method previously described for the solution of eigenvalue–eigenfunction problems in several variables has been applied to the Schrodinger wave equation for the lithium atom. The method employs an expansion of the wavefunction in terms of Slater determinants. Some information is obtained about the convergence behavior of such expansions, the convergence being too slow in this instance to yield an energy of useful accuracy. (auth)

21857 EXCITATION OF INERT GASES DURING ELECTRON-ATOM COLLISIONS. V. XENON. Fel'tsan, P. V.; Zapesochnyi, I. P. Ukr. Fiz. Zh., 13: 205-10(Feb. 1968). (In Russian).

Experimental investigations were made of cross sections of spectral line excitation and their energy dependence on the collisions of electrons with xenon atoms. Lines having the configuration levels $5p^56p$ and $5p^57p$ for their upper ones were mainly measured. All in all, 34 lines were investigated over a range of 4500 to 9930 Å. The cross sections were determined at the energy of maximum excitation efficiency. The results of measuring the cross sections of line excitation are presented. The functions of line excitation from the levels $2p_1$, $2p_5$, $2p_7$, $3p_5$ and $3p_7$ have two maxima. The first one is, as for the lines from the rest of 2p levels, beyond an excitation threshold within the limits of a threshold energy unit. The second maximum (more sloping) is at great energy values, but not exceeding five threshold units. The reason for appearing first maxima (at 16 eV) on the lines from the levels $2p_1$, $2p_4$, $3p_5$ may be cascade transitions, and for the second maxima from the levels $2p_7$ and $3p_7$ — cascade transitions and xenon ion recombination. (auth)

21858 APPLICABILITY OF RAIZER'S METHOD OF CALCULATING THE DEGREE OF IONIZATION OF A MULTIPLY IONIZED IDEAL GAS. Menendez, M. G.; Sexton, J. L. (Martin Marietta Corp., Orlando, Fla.). J. Appl. Phys., 39: 1919-21 (Feb. 15, 1968).

Raizer's method yields results for the thermodynamics properties of air which are in good agreement with Saha calculations. This is in accord with findings that the approximate method works well for mixtures composed of similar elements. (M.H.R.)

21859 DIFFRACTION THEORY OF SCATTERING BY HYDROGEN ATOMS. Franco, Victor (Univ. of California, Berkeley. Los Alamos Scientific Lab., N. Mex.). Phys. Rev. Lett., 20: 709-12(Apr. 1, 1968).

Diffraction theory is applied to elastic and inelastic scattering of charged particles by hydrogen atoms. At small momentum transfers the calculated intensities for elastically scattered electrons are significantly greater than those calculated by the first Born approximation. (auth)

21860 NEGATIVE-MUON DEPOLARIZATION IN LOW-Z ELEMENTS AND HYDROGEN COMPOUNDS. Buckle, D. C.; Kane, J. R.; Siegel, R. T.; Wetmore, R. J. (College of William and Mary, Williamsburg, Va.). Phys. Rev. Lett., 20: 705-8 (Apr. 1, 1968).

A polarized negative muon is known to depolarize strongly in the process of forming a muonic atom in the ground state. Several calculations have been made in which this effect is treated as the net result of successive spin-orbit interactions encountered in the muonic cascade. Muon–electron asymmetry results are reported for the elements C and Mg, and the following hydrogenous materials: H_2O, C_7H_8 (toluene and polyvinyltoluene), and CH_2 (paraffin and polyethylene). (M.O.W.)

21861 PRECISION MEASUREMENTS OF W FOR POLONIUM ALPHA PARTICLES IN VARIOUS GASES. Jesse, William P. (St. Procopius Coll., Lisle, Ill.). Radiat. Res., 33: 229-37 (1968).

Precision measurements of W, the average energy to make an ion pair, have been made with ^{210}Po alpha particles in a number of commonly used gases. These measurements agree in general with earlier measurements, but the limits of error have been greatly reduced. A particularly good measurement of W_α in argon of 26.38 ± 0.04 eV/ion pair has been obtained. If one uses this value in connection with the measured ratio of ionization in air to that in argon under similar beta-particle bombardment, one

can determine a value for $W_{\beta\ air}$ if one assumes the equivalence of W_β and W_α in argon. The value thus obtained of $W_{\beta\ air} = 33.88 \pm 0.06$ eV/ion pair is believed to be very close to the true value for $W_{\beta\ air}$. At any rate, it should serve as an upper limit to possible values for $W_{\beta\ air}$. (auth)

21862 ELECTRON-MICROPROBE DETERMINATION OF THE ANGULAR DISTRIBUTION OF SPUTTERED ALUMINUM ATOMS. Hasseltine, E. H.; Olson, N. Thomas; Smith, Harold P. Jr. (Univ. of California, Berkeley). J. Appl. Phys., 39: 1417-19(Feb. 15, 1968).

A technique for the determination of relative surface densities of very thin films with an electron microprobe was developed and applied to the measurement of the angular distribution of aluminum atoms sputtered from a monocrystalline aluminum target by 5 to 10-keV cesium ions. In all measurements the ion beam was normal to the target surface and the (100) crystallographic plane. Peaks in the distribution were noted at polar angles to the incident beam of 27 and 45°. The distribution exhibited no temperature dependence between 77 and 475°K. (auth)

21863 MATRIX ELEMENTS OF THE SPIN–ORBIT INTERACTION ENERGY OPERATOR FOR AN OPEN SHELL OF ATOMIC ELECTRONS BEING OUTSIDE CLOSED SHELLS. Vizbaraite, Ya. I.; Karaziya, R. I.; Grudzinskas, I. I.; Yutsis, A. P. (Kapsukas State Univ., Vilnyus, USSR. Inst. of Physics and Mathematics, Vilnyus, USSR). Liet. Fiz. Rinkinys, Liet. TSR Mokslu Akad., Liet TSR Aukst. Mokyklos, 7: 5-26(1967). (In Russian).

General formulae are developed for the reduced matrix elements of the spin–orbit interaction energy operator for the configuration consisting of one open and any number of closed shells. The tables of the expressions for the reduced matrix elements of the operator mentioned above for the interaction inside the shells of p and d electrons are given. The exact expressions for the spin–orbit coupling constant including the shells of g electrons are given. (auth)

21864 INVESTIGATION OF FEYNMAN DIAGRAMS OF THE FIRST AND SECOND ORDERS FOR SOME STATES OF LIGHT ATOMS. I. EXPRESSION OF THE DIAGRAMS CONTRIBUTIONS OF THE FIRST AND SECOND ORDERS BY RADIAL INTEGRALS. Safronova, U. I.; Tolmachev, V. V. (Karpov Inst. of Physical Chemistry, Moscow). Liet. Fiz. Rinkinys, Liet. TSR Mokslu Akad., Liet. TSR Aukst. Mokyklos, 7: 53-72(1967). (In Russian).

The field form of perturbation theory is applied to the degenerate states of atoms. The diagram contributions for ΔE are given in the first and second orders of perturbation theory. Summing up the moment projects has been carried out completely. The diagram contributions are expressed by the radial integrals. (auth)

21865 NEW EMISSION MECHANISM OF OXYGEN GREEN LINE λ 5577 IN A GLOW DISCHARGE. Watadani, Kunihiko (Tottori Univ., Japan). J. Geomagnet. Geoelec., 19: 273-9(1967).

Experimental conditions under which the forbidden line of oxygen atom, λ 5577, is emitted in a low pressure glow discharge tube containing a mixture of argon and oxygen gas, were studied. Examining the pattern of the intensity variation of the line, according to the total pressure and the mixing percent of oxygen, it was proposed that the exciting mechanism of the state $O(^1S_0)$ may be classified into two types: (A) high pressure and low oxygen percentage type and (B) low pressure and high oxygen percentage type. The main process of the type-A mechanism is inferred to be $O^+(^4S) + e \rightarrow O(^1P^0) \rightarrow O(^1S_0) + h\nu$ (λ 1218), where the metastable argon atoms are supposed to be acting as powerful sources of the atomic ions $O(^1P^0)$ The type-B mechanism is supposed to be the one suggested by McLennan, that is, $A(^3P_2) + O_2(X^3\Sigma_g^-) \rightarrow A(^1S_0) + O(^1S_0) + O(^1D_2) + 0.26$ eV. (auth)

21866 SOME OBSERVATIONS OF SURFACE SEGREGATION BY AUGER ELECTRON EMISSION. Harris, L. A. (General Electric Research and Development Center, Schenectady, N. Y.). J. Appl. Phys., 39: 1428-31(Feb. 15, 1968).

Surface segregation of sulfur in nickel and steel, and of chromium and antimony in steel have been observed using an Auger electron method of analysis. The method provides a useful technique for studies of diffusion and segregation in solids. (auth)

21867 ANALYSIS OF MATERIALS BY ELECTRON-EXCITED AUGER ELECTRONS. Harris, L. A. (General Electric Research and Development Center, Schenectady, N. Y.). J. Appl. Phys., 39: 1419-27(Feb. 15, 1968).

The energy spectra of Auger electrons emitted from many elements and alloys have been observed. Differentiation of the secondary electron-energy distribution by perturbation and synchronous detection techniques, and suppression of the effects of low-energy secondaries, were used to obtain well-defined spectra. The Auger lines afford a sensitive indicator for light elements, though spectra for elements as heavy as gold have been obtained. Because the method examines only a superficial layer of the sample, it is useful for detecting contamination, surface migration, or segregation, and for diffusion studies. Cleaning of the surfaces is critical for useful analysis. Quantitative analysis is hindered by noise and the lack of known surface conditions for calibration. (auth)

21868 ANGULAR DEPENDENCE OF THE LASER PHOTODETACHMENT OF THE NEGATIVE IONS OF CARBON, OXYGEN, AND HYDROGEN. Hall, J. L.; Siegel, M. W. (National Bureau of Standards, Boulder, Colo. Univ. of Colorado, Boulder). J. Chem. Phys., 48: 943-5(1968).

Crossed ion and laser beams were used to determine the angular distribution of electrons detached from H^-, O^-, and C^- ions. For H^- the expected $\cos^2\theta$ behavior was obtained. For C^- and O^- a more nearly $\sin^2\theta$ distribution was found. These results agree with calculations made by Cooper and Zare [J. Chem. Phys., 48: 942-3 (1968)]. It is concluded that in O^- and C^- the $p \rightarrow s$ wave and $p \rightarrow d$ wave photodetachment channels interfere destructively. (A.G.W.)

21869 REFLECTION OF IONS OBLIQUELY INCIDENT ON A SINGLE CRYSTAL. Yurasova, V. E.; Karpuzov, D. S. (Moscow State Univ.). Sov. Phys.-Solid State (Engl. Transl.), 9: 1971-8 (Mar. 1968).

Translated from Fiz. Tverd. Tela, 9: 2508-13(Sept. 1967).

By simulating trajectories, a machine calculation was made for the reflection of copper ions having 3-keV energy and argon ions of 2.2-keV energy from the surface of a copper single crystal. Oblique incidence of the ions on the {110} phase at angles $\alpha = 45$ and 70° (measured from the normal to the surface) and in the {100} plane at an angle of 70° was considered. Plots of the angular and energy distributions for the scattered ions were obtained. It is demonstrated that for large incident angles a considerable portion of the ions exit near the plane of incidence. A minimum number of ions are reflected in the directions of the closest-packed atoms. The form of the angular and energy distributions depends on the direction of incidence of the ion beam. (auth)

21870 DEPENDENCE OF THE SPUTTERING COEFFICIENTS OF POLYCRYSTALLINE TARGETS ON THE ANGLE OF INCIDENCE OF IONS. Evdokimov, I. N.; Molchanov, V. A. (Moscow State Univ.). Sov. Phys.-Solid State (Engl. Transl.), 9: 1967-70(Mar. 1968).

Translated from Fiz. Tverd. Tela, 9: 2503-7(Sept. 1967).

A study was made of the dependences of the sputtering coefficients of polycrystalline copper, nickel, molybdenum, and silver targets on the angle of incidence of neon, argon, and krypton ions of about 30-keV energy. It was found that the angular dependence of sputtering coefficients of polycrystalline targets was, in general, nonmonotonic. This could be explained by allowing for the short-range in the distribution of surface atoms of the target. (auth)

21871 ORTHOGONAL CHANNEL PROJECTIONS IN HIGH-ENERGY ION–ATOM COLLISIONS WITH ELECTRON EXCHANGES. Hahn, Yukap; Russek, Arnold (Univ. of Connecticut, Storrs). Phys. Rev., 168: 78-85(Apr. 5, 1968).

Approximately orthogonal channel projection operators are constructed for the charge-exchange processes in ion–atom collisions at high energies. The adiabatically perturbed stationary-state wave functions are suitably modified to take into account the motion of the heavy cores to which electrons are bound. By proper adjustment of the phase factors, it is shown that the orthogonality property between states in the modified set can be maintained. The resulting projection operators are mutually orthogonal everywhere in the configuration space, and satisfy the asymptotic requirements to first order in the electron–ion mass ratio. Single asymmetric and symmetric charge exchanges as well as double exchanges are studied in some detail, but no actual applications are given. (auth)

21872 ABSOLUTE CROSS SECTIONS FOR SIMULTANEOUS IONIZATION AND EXCITATION OF N_2 BY ELECTRON IMPACT. Srivastava, B. N.; Mirza, I. M. (Univ. of Alaska, College). Phys. Rev., 168: 86-8(Apr. 5, 1968).

Cross sections for the excitation of the (0,0) band of the N_2^+ first negative and the (4,1) band of the N_2^+ Meinel system by electron impact on nitrogen have been measured. The maximum effective cross sections for the (0,0) first negative and for the (4,1) Meinel band are 1.68×10^{-17} and 6.76×10^{-19} cm^2, respectively. The maximum cross section for both systems occurs in the energy range 90 to 110 eV. (auth)

21873 RESONANCES IN THE TOTAL CROSS SECTIONS FOR METASTABLE EXCITATION OF NOBLE GASES BY ELECTRON IMPACT. Pichanick, F. M. J.; Simpson, J. Arol (Na-

tional Bureau of Standards, Washington, D. C.). Phys. Rev., 168: 64-70(Apr. 5, 1968).

Total cross sections for excitation by electron impact of metastable states in the noble gases helium, neon, argon, krypton, and xenon have been measured as a function of impact energies. A 180° spherical monochromator was used to obtain incident beams of electrons with energy resolutions between 0.035 and 0.050 eV. Metastable atoms were detected in the scattering chamber by electron ejection from a metal surface. The detector was biased negatively to repel scattered electrons, and was electrostatically shielded from the incident electron beam. The cross sections were measured for impact energies up to 5 eV above the metastable thresholds. Several narrow resonances associated with negative-ion states were observed, and where possible their shapes and positions on the energy scale were compared with similar results obtained by different techniques. (auth)

21874 ASSOCIATIVE DETACHMENT: $H + H^- \rightarrow H_2^* + e$. Chen, Joseph C. Y.; Peacher, Jerry L. (Univ. of California, San Diego, La Jolla). Phys. Rev., 168: 56-63(Apr. 5, 1968).

The process of associative detachment in the (H,H^-) collision system is investigated at energies below 12 eV. In this energy region, the interaction potential between H and H^- has recently been determined. The energy dependence of the cross section is calculated with explicit allowance for the production of "hot" hydrogen molecules. It is observed that associative detachment provides a possible mechanism for generating an inverted population of the residual molecule such as H_2. (auth)

21875 ABSOLUTE EXCITATION CROSS SECTIONS OF HELIUM LEVELS BY LOW-ENERGY ELECTRONS. Zapesochnyi, I. P. (Uzhgorod State Univ., USSR). Astron. Zh., 43: 954-62 (1966). (In Russian).

New data are obtained on the cross sections for excitation of helium atoms by slow electrons. It is found that the excitation of the majority of helium levels is characterized by two maxima, one of which occurs directly at the threshold. The behavior of the excitation cross sections of the levels used as a basis for determining the absolute excitation cross sections for the resonance and both metastable levels in the region of electron energies between the threshold and 120 to 160 eV. The agreement with theory of the absolute excitation functions of the 2^1S, 2^3S, and 2^3P levels is satisfactory. Complete data on the cross sections of helium levels at maximum excitation, ($\delta > 10^{-20}$ cm^2) are given. (ATD)

21876 ANALYSIS OF LOW-ENERGY ELECTRON SCATTERING BY HELIUM, NEON, AND ARGON. Hoeper, P. S.; Franzen, W.; Gupta, R. (Boston Univ.). Phys. Rev., 168: 50-5 (Apr. 5, 1968).

A least-squares method has been used to fit Ramsauer and Kollath's data on the scattering of electrons from helium, neon, and argon with a set of four phase shifts. All the known experimental points between 1.0 eV and an energy 0.6 eV below the threshold for inelastic scattering in each gas were analyzed. The effect of spin-orbit splitting on the description of the scattering has been neglected, as usual. The angular distributions and the total cross sections computed from the four phase shifts at each energy agree well with the original data, except possibly for argon, where more than four phase shifts are probably required. A graphical comparison has been made between the variation with energy of the phase shifts so determined and various recent theoretical predictions, as well as Andrick and Ehrhardt's recent direct measurements. (auth)

21877 NONORTHOGONAL FORMULATION OF HARTREE–FOCK PERTURBATION THEORY. Duff, K. J.; Das, T. P. (Univ. of California, Riverside). Phys. Rev., 168: 43-9(Apr. 5, 1968).

Perturbation theory, up to first order in the wave function and second order in the energy, is formulated for a many-electron system without requiring the perturbed one-electron states to be orthogonal. The most general self-consistent coupled equations, referred to as Method 1, form the counterpart of Langhoff, Karplus, and Hurst's (LKH) Method a for orthogonal orbitals. The uncoupling of the perturbations $\delta\psi_i$, $\delta\psi_j$ to the zero-order wave functions ψ_i^0 and ψ_j^0 produces equations referred to as Method 2. Further approximation in the Method-2 equations yields a set of equations called Method 3. Methods 2 and 3 are counterparts of LKH's Method b, but have computational advantages over Method b in that normalization and orthogonalization are accomplished in a particularly simple fashion. In comparing the uncoupled Method-3 equations with Dalgarno's equations, an additional difference is found involving the overlap integral between perturbed states, besides the difficulty pointed out by LKH. Application of the Method-2 and -3 equations is made to the spin-polarization problem of the Fe^{+3} ion, leading to a hyperfine constant in reasonable agreement with earlier unrestricted Hartree–Fock (UHF) calculations. A comparison between results obtained by Methods 2 and 3 and Dalgarno's equations permits a relative evaluation of these methods. The effect of indirect spin polarization of the s electrons was also studied through the action of the p electrons, which are in turn polarized by the unpaired d electrons. This contribution is found to be about 10% of the direct effect. (auth)

21878 SPIN MAGNETIC EFFECT ON THE POLARIZATION OF THE ELECTRON–ATOM IMPACT RADIATION. Chiu, Lue-Yung Chow (Goddard Space Flight Center, Greenbelt, Md.). Phys. Rev., 168: 32-43(Apr. 5, 1968).

A new mechanism is proposed to explain the discrepancies between the measured and the expected polarization of the electron–atom impact radiation at threshold energy. The idea is the following: At threshold scattering, the spin of the scattered electron interacts magnetically with the orbital motion of the atomic electrons. The component of this magnetic interaction along the quantization axis, which is perpendicular to the incident electron direction, will split the magnetic sublevels of the atomic excited states. This splitting will cause the coherent interference of the radiation, which originates from two degenerate upper levels and ends on a single lower level, to become ineffective. The polarization of the radiation is thereby affected and in fact decreases. The expected polarization P is modified by a depolarization factor $f = (1 + \langle\omega^2\rangle_{Av}\tau^2)^{-1}$, where ω is the frequency splitting of the excited state, and τ is the lifetime of the transition from the excited upper state to a lower state. By using a simple product wave function for the state, the ω and hence the P for various singlet–singlet transitions and triplet–triplet transitions have been calculated for the helium atom. In general, when the principal quantum number n of the excited state, where the radiation originates, increases, f also increases and approaches unity. Consequently, P increases and approaches the expected value. For example, P for the $3^1P \rightarrow 2^1S$ (5016 Å) line turns out to be 1.2%, whereas for the $4^1D \rightarrow 2^1P$ (4922 Å) line it turns out to be 50%. The expected values are 100% and 60%, respectively. In the case of triplet–triplet transitions, the spin–spin interaction between the scattered electron and the atomic electrons is also included. (auth)

21879 EXTENDED POLARIZATION POTENTIAL: APPLICATIONS TO ATOMIC SCATTERING. Callaway, Joseph (Louisiana State Univ., Baton Rouge); LaBahn, R. W.; Pu, R. T.; Duxler, W. M. Phys. Rev., 168: 12-21(Apr. 5, 1968).

In the calculation of the scattering of low-energy charged particles by atoms, corrections must be made to the usual polarization potential. The most important of these is a distortion potential, arising from the action of the kinetic-energy operator for the scattered particle on the perturbed wave function for the atom. A formal expression for this potential is obtained for any atom. It is evaluated approximately for hydrogen and helium. The combination of the distortion potential and the ordinary polarization potential is called the extended polarization potential; it is much weaker than either separately. Calculations of the scattering of low-energy positrons and electrons by hydrogen and helium atoms are performed in which the extended polarization potential is employed. Computed phase shifts and cross sections are compared with experiment and with other theoretical calculations. (auth)

21880 RAYLEIGH SCATTERING AND THE ELECTROMAGNETIC SUSCEPTIBILITY OF ATOMS. Johnson, W. R.; Feiock, F. D. (Univ. of Notre Dame, Ind.). Contract AT(11-1)-427. Phys. Rev., 168: 22-31(Apr. 5, 1968). (COO-38-565).

Rayleigh scattering of light by atoms is considered from the point of view of relativistic electron theory. The relationship between the coherent S-matrix element and the frequency-dependent electric and magnetic multipole susceptibilities of the atom is established. Single-particle radial equations are derived for the perturbed electron orbitals, assuming that the atom is described by a relativistic Hartree–Fock–Slater (RHFS) wave function. These equations reduce to the inhomogeneous Schrödinger equations commonly used to evaluate electric polarizabilities when relativistic (fine-structure) effects are neglected. Numerical solutions to the radial equations are obtained for the noble gases. The electric- and magnetic-dipole susceptibilities are compared with previous nonrelativistic calculations as well as with experimental values. The magnetic susceptibilities are found to be essentially independent of frequency, and to agree to within 1% with static experimental values for all of the noble gases except He. The accuracy of the electric polarizability decreases from about 5% for He and Ne to about 50% for Xe. Relativistic effects are almost entirely negligible for magnetic susceptibilities; they are noticeable only in the case of Xe. In the electric polarizability calculations, relativistic effects are completely masked by the crude nature of the RHFS computational techniques. (auth)

21881 RECONCILIATION OF EXPERIMENTAL LAMB SHIFTS. Robiscoe, R. T. (Univ. of Michigan, Ann Arbor). Phys. Rev., 168: 4-11(Apr. 5, 1968).

A detailed analysis of the metastable quenching problem encountered in the recent level-crossing measurements in the n = 2 state of atomic hydrogen is developed. The analysis allows calculation of a previously unaccounted systematic correction to the value of the Lamb shift S derived from these measurements. This correction, together with refinements in the calculation of S from a measured crossing, decreases our value to S = 1057.86 ± 0.10 MHz. Within experimental error, this value agrees with the original result as measured by Lamb and collaborators. In addition, the analysis allows the calculation of a new upper limit to the parity impurity amplitude in the 2S state of atomic hydrogen, namely $|a_0|^2 \leq 8 \times 10^{-9}$, at zero magnetic field. (auth)

21882 CALCULATION OF LOW-ENERGY ELECTRON-ATOM TRANSPORT CROSS SECTIONS FROM TOTAL CROSS-SECTION MEASUREMENTS. Fox, R. L. (Sandia Corp., Albuquerque, N. Mex.). Phys. Rev., 168: 1-3(Apr. 5, 1968).

Modified effective-range theory (MERT) is used to determine the cross sections necessary for calculation of electron–atom transport coefficients. Two means of obtaining the transport cross sections are given: (1) direct integration of the weighted MERT differential cross section, and (2) inserting MERT phase shifts in a partial-wave formula for the transport cross sections. Both of these approaches are applied to e^-–Ar collisions, and it is found that the second method is more useful for energies above 10^{-3} eV. The constants given by Golden and Bandel are used to calculate the first four transport cross sections for e^-–Ar and e^-–He collisions for energies below 0.5 and 2 eV, respectively. (auth)

21883 RELATIVE POPULATION OF N^+ AND N_2^{++} IN A "MASS-14" ION BEAM. Vance, Dennis W. (Xerox Corp., Rochester, N. Y.). J. Chem. Phys., 48: 1873-4(Feb. 15, 1968).

Results of measurements of the number of secondary electrons produced by bombardment of an atomically clean polycrystalline Mo ribbon with a mass-14 ion beam indicate contamination of the beam by N_2^{++} ions. The percentage of N_2^{++} in the beam is estimated to be between 6 and 11%. (A.G.W.)

21884 CHARGE-EXCHANGE CROSS SECTIONS OF N_2^{2+} IN N_2, CO_2, AND Ar AND CONTAMINATION OF N^+ BEAMS BY N_2^{2+}. Savage, H. F.; Witteborn, F. C. (Ames Research Center, Moffett Field, Calif.). J. Chem. Phys., 1872-3(Feb. 15, 1968).

In measurements of the dependence of N_2^{++} content in N^+ beams on source conditions the ratio of N_2^{++} ions to N^+ was found to be 10^{-4} when 50-eV electrons were used in the ion source and 10^{-6} at electron energies of 30 to 40 eV. Charge-exchange cross sections for N_2^{++} in N_2, CO_2, and Ar were measured for incident ion energies from 100 to 1000 eV. Cross sections for transferring an electron from the background gas to an N_2^{++} ion yielding N_2^+ and cross sections for removing N_2^+ from the beam for different incident ion energies are tabulated. (A.G.W.)

21885 PROJECTED HARTREE PRODUCT WAVEFUNCTIONS. Gallup, G. A. (Univ. of Nebraska, Lincoln). J. Chem. Phys., 48: 1752-9(Feb. 15, 1968).

A method for performing a restricted configuration interaction calculation on atoms or molecules based on the use of Young operators from the symmetric groups is discussed and its relation to some other types of calculations is pointed out. The method in its most general form can be said to be an extension of the independent-particle approach, which represents the wave function in terms of the n best possible one-particle orbitals for the n-particle system. Illustrations are given for the hydrogen molecule, the helium atom, and the allyl radical. (auth)

21886 ABUNDANCE OF EXCITED IONS IN O^+ AND O_2^+ ION BEAMS. Turner, B. R.; Rutherford, J. A.; Compton, D. M. J. (Gulf General Atomic Inc., San Diego, Calif.). J. Chem. Phys., 48: 1602-7(Feb. 15, 1968).

A method has been developed to determine the fraction of excited ions present in an ion beam formed using various energies E_i of the ion source. The determination is made ~20 μsec after formation of the ions so that only long-lived states remain in the beam, as is usual in beam experiments. The method consists of attenuating the ion beam in a gas-filled reaction chamber, where different states of the ions suffer different attenuations. Results have been obtained for O_2^+ and O^+ ion beams. In each case only one excited state appears to be important: for O_2^+ the fraction f of this excited state was found to be 0.22, 0.30, and 0.33 for E_i values of 25, 50, and 100 eV, respectively; for O^+, f is 0.27 for E_i = 50 eV and 0.30 for E_i = 100 eV. The use of these results is illustrated by combining them with crossed-beam measurements of charge transfer to determine separately the cross sections for the ground state and the excited-state ions of O^+ and O_2^+. (auth)

21887 ION–MOLECULE AND CHEMI-IONIZATION REACTIONS IN H_2 BY PHOTOIONIZATION. Chupka, W. A.; Russell, M. E.; Refaey, K. (Argonne National Lab., Ill.). J. Chem. Phys., 48: 1518-27(Feb. 15, 1968).

The production of H_3^+ by ion–molecule and chemi-ionization processes initiated by photon impact in H_2 has been studied as a function of photon energy with resolution widths varying from 0.05 to 0.002 eV. The purpose was to determine how the vibrational energy of the reactant ion affects the reaction cross section. The data indicate that the reaction $H_2^+ + H_2 \rightarrow H_3^+ + H$ proceeds by at least two different mechanisms. At very low kinetic energies, the dominant mechanism has a reaction cross section that decreases slowly as the vibrational energy of the ion increases. At higher kinetic energy, a mechanism for which the cross section increases with increasing vibrational energy of the ion becomes more prominent. The characteristics of the first mechanism suggest the formation of a collision complex while those of the latter suggest a mechanism such as stripping. At low kinetic energies, the rotational energy of the ion has only a small effect on the reaction cross section. Some of the production of H_3^+ by chemi-ionization below the ionization threshold of H_2 is shown to involve excited H atoms, probably in the 2^2S metastable state, as well as excited H_2 molecules. The cross section for chemi-ionization by excited H atoms was found to decrease with kinetic energy; this behavior is discussed. The proton affinity of H_2 was found to be ≥3.936 eV. (auth)

21888 PERTURBATION TREATMENT OF LARGE-ANGLE ELASTIC SCATTERING. Cross, R. J. Jr. (Yale Univ., New Haven). J. Chem. Phys., 48: 1480-7(Feb. 15, 1968).

A perturbation treatment, valid for small impact parameters, is developed for the WKB phase shift and the classical deflection angle for a general Lennard-Jones potential. The unperturbed problem is the scattering at zero impact parameter from a repulsive interaction given by Cr^{-s}. The centrifugal term in the effective potential and an attractive term are added as perturbations. The phase shift and deflection angle are obtained as a simple series to third order in both perturbations. A simple expression is obtained for the large-angle differential cross section, which may be used to obtain the well depth ϵ and the power of the repulsive wall s. (auth)

21889 MULTIPLE SCATTERING IN THE GAUSSIAN APPROXIMATION: SYSTEMATIC IMPROVEMENT OF THE SMALL-ANGLE TREATMENT. Hemmer, P. C.; Farquhar, I. E. (Norges Tekniske Hoegskole, Trondheim, Norway). Phys. Rev., 168: 294-301(Apr. 10, 1968).

In the theory of the elastic multiple scattering of a charged particle in a plane, it is usually assumed that all angles involved are small. Working in the Gaussian approximation, a power-series expansion is used to effect a systematic improvement of the results of the small-angle approximation, these being the zero-order approximation to our expansion. A method of integration in function space is used to determine the joint probability of lateral and angular displacements of the scattered particle, in principle to any order in the expansion parameter; this computation is carried out explicitly to first order in the parameter. This joint probability is employed to obtain first-order corrections to previous results concerning, first, the lateral displacement y(L/2) midway between two selected points a distance L apart on the track of the scattered particle, and second, the mean squared curvature $\langle C^2 \rangle_{av}$ of the track; in the former instance the result is $\langle y^2(L/2) \rangle_{av} = (L^3/48\lambda)\{1 + (23L/96\lambda)\}$, where λ is the scattering parameter, and in the latter, $\langle C^2 \rangle_{av} = (4/3\lambda L)\{1 - (25L/96\lambda)\}$. For tracks both in two and in three dimensions, first-order corrections are determined also to results of the small-angle approximation for the actual path length of particles passing through a foil, both when the particles emerge normally to the foil and when they emerge in any direction. The results indicate that the discrepancy reported between theoretical predictions and some experimental measurements of multiple scattering is not attributable to the use of the small-angle approximation in the theoretical description. (auth)

21890 STATISTICAL FLUCTUATIONS OF ENERGY DEPOSITED IN LOW-ATOMIC-NUMBER MATERIALS BY 43.7-MeV PROTONS. Hilbert, Jerald W. (Hughes Research Labs., Malibu, Calif. Univ. of California, Los Angeles); Baily, Norman A.; Lane, Richard G. Phys. Rev., 168: 290-3(Apr. 10, 1968).

The frequency distribution of energy losses in a He–CO_2 mixture by 43.7-MeV protons was investigated by means of a proportional-counter technique. The distributions corresponding to mean energy losses of 1.64, 8.22, 16.4, and 49.5 keV were examined. Relatively good agreement was found between experimental data and Vavilov's formulation of the Landau effect for the 49.5-keV

distribution. For the other distributions, corresponding to smaller mean energy losses, the discrepancy between experiment and theory increased as the mean energy loss decreased. Correction of the Vavilov distributions by use of the Blunck–Leisegang factor gave good agreement with the experimental data. (auth)

21891 INELASTIC SCATTERING OF COLD NEUTRONS FROM LIQUID ARGON AT ELEVATED TEMPERATURES. Andrus, W. S. (Brookhaven National Lab., Upton, N. Y. State Univ. of New York, Stony Brook); Muether, H. R.; Palevsky, H. Phys. Lett., 26A: 152-3(Jan. 15, 1968).

The scattering of 4Å neutrons from liquid argon has been measured. The temperature dependence of the quasi-elastic width is inconsistent with the free diffusion hypothesis. The data are in agreement with Singwi's theory of coherent quasi-elastic scattering from liquids. (auth)

21892 BREMSSTRAHLUNG PASSAGE THROUGH ALKALI METAL HALIDE CRYSTALS AT DIFFERENT COLLIMATION OF BEAMS. Vorob'ev, V. A.; Sokolov, G. P. (Tomsk Polytechnic Inst., USSR). Izv. Vyssh. Ucheb. Zaved., Fiz., No. 12, 110-12 (1967). (In Russian).

Variations of the 10-MeV bremsstrahlung mean energy in various thickness alkali metal halide crystals were calculated using the Monte Carlo method. The results obtained showed that the mean energy increased with the thickness of crystals; for potassium iodide it increased over twofold during passage through 80 80 g/cm² thickness and radiation field of 1 cm in diameter. The maximum difference of the mean energy in the transition from potassium chloride to potassium iodide, at identical irradiation fields, was 0.2 to 0.3 MeV, while irradiation field increase from 10 to 100 mm diameter resulted in energy increase of more than 0.5 (with the crystal thickness of 100 g/cm²). With the 10-mm bremsstrahlung beam transition to an infinite irradiation field the energy increased to over 1 MeV. (R.V.J.)

21893 ENERGY LOSS OF ELECTRONS OF 0.6 TO 1.2 MeV IN RELATIVELY THICK Al FOILS. Hara, Eiichi (Hitachi Central Research Lab., Tokyo). Jap. J. Appl. Phys., 7: 335-41(Apr. 1968).

Energy distributions of electrons passing through Al foils of 100- to 800-μ thickness in their normal direction from a Van de Graaff-type electron accelerator were examined with a 60° deflecting analyzing magnet for initial electron energies from 0.6 to 1.2 MeV. The most probable energy loss and the average energy loss were compared with the theoretical values deduced by Landau for heavy particles and those obtained by Bethe for electrons scattered in all directions, respectively. Although the experimental values and the theoretical ones do not have exactly the same physical meanings, they seem to be in agreement, but the Blunck-Leisegang theory which is based on the Landau formulation fails to explain the energy distribution curves obtained experimentally. (auth)

21894 ANGULAR DEPENDENCE OF ENERGY SPECTRA OF SECONDARY IONS SCATTERED BY THE SURFACE OF MONOCRYSTALS. Arifov, U. A.; Aliev, A. A. (Inst. of Electronics, Tashkent). Z. Eksp. Teor. Fiz., 54: 354-61(Feb. 1968). (In Russian).

A study was made by the dynamic method of the angular dependence of the energy spectra of secondary ions under the bombardment of the molybdenum monocrystal faces (100) and (110) by K^+ ions with energies of 25 to 5000 eV. The energy spectrum of secondary ions has a structure connected with multiple collisions of incident ions with atoms of the target. It was found that a decrease of the scattering angle leads to an increase in intensities of the peaks corresponding to multiply scattered ions, which is explained by an increase in the number of repeatedly colliding ions. (auth)

21895 SOME PECULIARITIES OF THE TRANSFER OF ROTATIONAL AND VIBRATIONAL ENERGIES IN ION–MOLECULE COLLISIONS. Polyakova, G. N.; Fogel, Ya. M.; Erko, V. F.; Zats, A. V.; Tolstolutskii, A. G. (Physical-Technical Inst. of Low Temperatures, Kharkov). Z. Eksp. Teor. Fiz., 54: 374-83(Feb. 1968). (In Russian).

A study was made of the distribution of N_2^+ ions in an excited state $B^2\Sigma_u^+$ originating in collisions of ions He^+, Li^+, Ne^+, Na^+, Ar^+, and K^+ with N_2 molecules by the rotational and vibrational energy levels. To this end measurements are made of the distribution of rotational line intensities in the band $\lambda = 4278$ Å of the first negative system of the ion N_2^+ (1 NGN$_2^+$) and the ratio of intensities of the bands $\lambda = 4236$ Å and $\lambda = 4278$ Å of the same system. A comparison of the distribution of the ions N_2^+ ($B^2\Sigma_u^+$) by the rotational and vibrational energy levels with a corresponding distribution of the initial molecules of N_2 warrants the conclusion that in all investigated cases the production of the N_2^+ ($B^2\Sigma_u^+$) ion in collisions of ions with N_2 molecules is accompanied by the transfer to this ion of rotational and vibrational energies. The results obtained are discussed on the basis of the concept that ion–molecule collisions accompanied by the electron excitation of the molecule, the change of its rotational and vibrational states may be caused by two factors: (1) change of the electron state of the molecule and (2) direct effect of the incident ion field on the motion of nuclei in the molecule. (auth)

21896 POLARIZATION OF CHARACTERISTIC X RADIATION. Mehlhorn, W. (Univ., Muenster, Ger.). Phys. Lett., 26A: 166-7 (Jan. 15, 1968).

It is shown that characteristic x radiation following the ionization of an inner electron ($n,l > 0$, $j > \frac{1}{2}$) by electron or proton impact should generally be polarized. (auth)

21897 EXCITATION OF HELIUM BY FAST PROTONS. Bell, K. L.; Kennedy, D. J.; Kingston, A. E. (Queen's Univ. of Belfast). J. Phys., B, 1: 218-29(Mar. 1968).

The first Born approximation cross sections for proton excitation of the ground state of helium to the n ^{1}P (n = 2 to 6) and n ^{1}D (n = 3 to 6) states were calculated using a six-parameter ground-state wave function and modified hydrogenic excited-state wave functions. In order to determine the accuracy of the results both the length and velocity formulations of the Born approximation integrals were evaluated, and these indicate that the approximate Born cross sections are within about 4% of the exact Born cross sections. A comparison of these cross sections is made with recent theoretical and experimental results. In general, the agreement between theory and experiment is not good. (auth) (UK)

21898 EXCITATION INDUCED BY 0.15 TO 1.0-MeV PROTONS IN MOLECULAR OXYGEN. Thomas, E. W.; Bent, G. D. (Georgia Inst. of Tech., Atlanta). J. Phys., B, 1: 233-9(Mar. 1968).

Absolute cross sections were measured for the emission of certain spectral lines of atomic and molecular oxygen induced during the passage of protons through molecular oxygen. The cross sections for the population of the $v' = 0$ and $v' = 1$ levels of the O_2^+ ($b\ ^4\Sigma$) excited state are, respectively, 1.33×10^{-17} and 0.95×10^{-17} cm² at 150 keV, and decrease towards higher energies. The ratio of these two populations is in reasonable agreement with a value of 1.21 obtained by Wacks (1964) using calculated Franck–Condon probabilities. (auth) (UK)

21899 THE EFFECT OF LONG-RANGE FORCES ON THE BEHAVIOUR OF ELECTRON–ATOM SCATTERING CROSS SECTIONS NEAR EXCITATION THRESHOLDS. II. RESULTS FOR SOME SIMPLE MODELS. Faisal, F. H. M. (London Univ.). J. Phys., B, 1: 187-94(Mar. 1968).

The method developed in the previous paper was used to determine the effect of long-range dipole forces on the threshold behavior of cross sections for three different mathematical models. Results were obtained for systems with degenerate as well as nondegenerate channels. It is found that for the nondegenerate case the α/r^2 potentials do not alter Wigner's law for short-range forces. The range of energy over which the short-range behavior is maintained, however, decreases progressively with the decrease of energy difference between the nondegenerate levels. For the exactly degenerate case Wigner's law is violated and the cross section tends to a finite value at the threshold. (auth) (UK)

21900 THE EFFECT OF LONG-RANGE FORCES ON THE BEHAVIOUR OF ELECTRON–ATOM SCATTERING CROSS SECTIONS NEAR EXCITATION THRESHOLDS. I. SOLUTION OF SCATTERING EQUATIONS IN THE ASYMPTOTIC REGION. Faisal, F. H. M. (London Univ.). J. Phys., B, 1: 181-6 (Mar. 1968).

In general, atomic potentials are long-range in nature and may affect the short-range threshold law of Wigner. In order to solve the threshold problem for atomic collisions generally, i.e., including long-range coupling between both degenerate and nondegenerate channels, methods of obtaining accurate asymptotic solutions of the radial scattering equations must first be devised. A method of obtaining such solutions in the asymptotic region for energies very near to the excitation thresholds is developed. (auth) (UK)

21901 A QUANTITATIVE ANALYSIS OF FAST METASTABLE HELIUM ATOMS IN COLLISIONS INVOLVING ELECTRON LOSS. Gilbody, H. B.; Browning, R.; Levy, G. (Queen's Univ. of Belfast). J. Phys., B, 1: 230-2(Mar. 1968).

The attenuation of a fast beam of helium atoms by electron-loss collisions during passage through hydrogen was carefully investigated. The measurements allow the metastable-atom population of the beam to be determined and, for the first time, permit separate measurements of the electron-loss cross sections for both ground-

state and metastable helium atoms. At 120 keV these are 7.3 ± 0.8 and 48 ± 8 $cm^2 \times 10^{-17}$, respectively. (auth) (UK)

21902 MAGNETIC POLARIZABILITY OF CLOSED SHELLS. Mattis, Daniel C. (Yeshiva Univ., New York). Phys. Rev. Lett., 20: 792-4(Apr. 8, 1968).

The polarizability of closed atomic shells near field inhomogeneities is discussed in connection with several problems of physical interest. It is found that magnetically "neutral" S = 0 atoms or closed shells are attracted and polarized by magnetic field gradients. The effect is demonstrated through sample calculations for noninteracting as well as for interacting electrons. (auth)

21903 OBSERVATION OF TWO-PHOTON CONTINUUM EMISSION FROM NEON IX. Elton, R. C.; Palumbo, L. J.; Griem, H. R. (Naval Research Lab., Washington, D. C.). Phys. Rev. Lett., 20: 783-6(Apr. 8, 1968).

A prominent peak observed in the soft x-ray continuum emission of a deuterium–neon plasma is associated with radiation from the two-photon decay of the 2^1S "metastable" state of heliumlike Ne IX. (auth)

21904 ELECTRON IMPACT EXCITATION OF ATOMS. Moiseiwitsch, B. L. (Queen's Univ., Belfast); Smith, S. J. Rev. Mod. Phys., 40: 238-53(Apr. 1968).

Theoretical aspects of the excitation of atoms by electron impact are considered. The atoms are examined in order of increasing complexity beginning with the simplest of all atomic systems, atomic hydrogen, and then in turn considering helium, the heavier inert gases, mercury, the alkali metals, oxygen, and nitrogen, as well as certain positive ions. The procedure is to commence with the simplest approximations and to introduce progressively the more involved and, in general, more accurate and revealing approximations. (M.O.W.)

21905 ROTATIONAL AND VIBRATIONAL EXCITATION OF MOLECULES BY LOW-ENERGY ELECTRONS. Phelps, A. V. (Westinghouse Research Corp., Pittsburgh). Rev. Mod. Phys., 40: 399-410(Apr. 1968).

Techniques for the determination of rotational and vibrational excitation cross sections of molecules by low-energy electrons are reviewed. The results of experiment are then compared with theory. High-energy resolution electron beam techniques are most useful for the measurement of the details of resonance-type, vibrational excitation cross sections. Cross section determinations from analyses of electron transport coefficients are most successful at energies near the threshold of vibrational excitation and for rotational excitation. High-frequency energy relaxation studies provide data on rotational excitation. A comparison of presently available experimental and theoretical results shows that some of the excitation processes, e.g., rotational excitation of N_2 and CO and vibrational excitation of CO near threshold, are accurately described by the longest-range forces and Born approximation. In other cases, e.g., vibrational excitation of N_2 and CO near 2 eV, the excitation is best described in terms of an electron resonance with the molecular potential. (auth)

21906 HYPERFINE STRUCTURE OF HDO AND D_2O BY BEAM MASER SPECTROSCOPY. Verhoeven, J.; Bluyssen, H.; Dymanus, A. (Katholieke Univ., Nijmegen, Netherlands). Phys. Lett., 26A: 424-5(Mar. 23, 1968).

The hyperfine structure in the rotational spectrum of HDO and D_2O has been investigated with a beam maser spectrometer. The evaluated hyperfine coupling constants have been compared with values, calculated in the rigid rotor model of the molecule. (auth)

21907 CRYSTALLINE FIELD EFFECTS AND FIRST-ORDER PHASE TRANSITION IN $ErCo_2$. Petrich, G.; Moessbauer, R. L. (Technische Hochschule, Munich). Phys. Lett., 26A: 403-4 (Mar. 23, 1968).

The temperature dependence of the nuclear hyperfine splitting of ^{166}Er has been measured in the magnetically ordered $ErCo_2$ compound, showing a first order magnetic phase transition. The measurements indicate a crystalline field interaction which is large compared to the exchange interaction. (auth)

21908 THEORETICAL EXCITATION RATES IN O VII. Bely, O. (Observatoire de Nice). Phys. Lett., 26A: 408-9(Mar. 23, 1968).

Theoretical calculations for the excitation of O VII by electron impact have been performed. The results are compared with the experimental data. (auth)

21909 ELASTIC SCATTERING AND INELASTIC TRANSITIONS. Callaway, J.; Laghos, P. S. (Louisiana State Univ., Baton Rouge). Phys. Lett., 26A: 394-5(Mar. 23, 1968).

The effect of inelastic scattering on the cross section for electronic excitation in the collision of slow atoms interacting by Van der Waals forces is estimated, and found to be small in usual circumstances. (auth)

21910 R_4 INVARIANTS FOR DOUBLY EXCITED STATES OF HELIUM. Wulfman, C. E. (Center for Theoretical Studies, Coral Gables, Fla. Mathematical Inst., Oxford). Phys. Lett., 26A: 397-8(Mar. 23, 1968).

The group R_4 provides two new invariants that usefully label those helium metastable states in which, to first approximation, both electrons are in the second quantum level. (auth)

Cosmic Radiation

Refer also to abstracts 21804, 21807, 21808, 22286, 22299, 22300, 22302, and 22550.

21911 INTERACTION CROSS SECTION OF NUCLEAR-ACTIVE PARTICLES WITH NUCLEI OF IRON IN THE 100 TO 1000 GeV. Denisov, E. V.; Denisova, V. G.; Kim, V. M.; Morozov, A. E.; Slavatinskii, S. A. Izv. Akad. Nauk SSSR, Ser. Fiz., 31: 1466-7(Sept. 1967). (In Russian).

The measurements were performed with the aid of a set of 20 series of ionization chambers with lead and iron absorbers at the Tyan'-Shan' Mountain Station. The apparatus was triggered whenever the energy released in the calorimeter exceeded 100 GeV. The interaction cross section was derived from the findings on the number of avalanches generated in various layers of the absorber; altogether 588 selected avalanches generated in upper layers of the absorber (Fe) were analyzed. The inelastic cross section for all the recorded events with energies exceeding 100 GeV amounted to 780 ± 80 mb—or an interaction path of (120 ± 12) $g \cdot cm^{-2}$—in Fe. For neutral particles (neutrons) the inelastic cross section was 850 ± 120 mb, i.e., an interaction path of 110 ± 15 $g \cdot cm^{-2}$. Measurements in 21-GeV accelerators showed that for Cu the inelastic cross section is 790 ± 32 mb; hence also, following substitution, for atomic nuclei of Fe we have an inelastic cross section of 700 ± 35 mb at 21 GeV. Thus, the inelastic cross section does not change markedly within the energy range of from 21 GeV to hundreds of GeV. (JPRS)

21912 NEUTRON–CARBON NUCLEUS INELASTIC INTERACTION CROSS SECTION AT ENERGIES OF 100 GeV. Alakoz, A. V.; Bolotov, V. N.; Devishev, M. I.; Klimanova, L. F.; Shmeleva, A. P. Izv. Akad. Nauk SSSR, Ser. Fiz., 31: 1463-5 (Sept. 1967). (In Russian).

Inelastic interaction of cosmic-ray neutrons with carbon nuclei was investigated at the Nor-Amberd Mountain Station (2000 m above sea level). The relation of the number of charged particles underneath a given mass of absorber to the energy of the incident nucleon was determined by calculating the electronic–nuclear cascades in filter material by the Monte Carlo method. The measurements established that the cross section of inelastic interaction between cosmic-ray neutrons in the 100-GeV range and the carbon nucleus amounts to 200 ± 24 mb. This figure is in satisfactory agreement with the data of other investigators insofar as measurements in cosmic rays are concerned but is lower than the figure derived from measurements on accelerators (254 ± 7 mb); the difference is attributable to the fact that in cosmic-ray experiments only the channel associated with the generation of new particles is measured, whereas in an accelerator various quasi-elastic scattering channels also are measured. (JPRS)

21913 RELATION OF NUCLEAR INTERACTION CROSS SECTION TO ATOMIC WEIGHT OF THE ELEMENT. Vardumyan, D. T.; Marikyan, G. A.; Matevosyan, K. A. Izv. Akad. Nauk SSSR, Ser. Fiz., 31: 1460-2(Sept. 1967). (In Russian).

The measurements were performed at the height of 2000 m above sea level with the aid of an ionization calorimeter, two spark chambers ($100 \times 60 \times 12$ cm) located above the calorimeter, and a hodoscopic system of Geiger–Mueller counters. Lead and aluminum absorbers, each of a thickness equal to 0.5 of nuclear path and each overlapping one-half of the solid angle of the apparatus, were mounted between the spark chambers with the object of determining the dependence of the nuclear interaction cross section on the atomic weight of each element. It was established that an increase in energy results in at most an extremely slow increase in the indicator α such that it remains roughly equal to $^2/_3$ up to energies of 10^{12} eV. (JPRS)

21914 LARGE-ANGLE SCATTERING OF COSMIC-RAY MUONS. Bugaev, E. V. Izv. Akad. Nauk SSSR, Ser. Fiz., 31: 1568-70(Sept. 1967). (In Russian).

The presence of photonuclear interaction is a major factor in

high transferred momenta. Hitashi et al. (Nuovo Cimento, 38, 107 (1965)) observed this process for values of the square of the transferred momentum of the order of 10 GeV^2. Further research into this interaction could be accomplished with apparatus located at sea level and capable of selecting cases of the motion of the cosmic-ray muon in the direction of the upper hemisphere (following large-angle scattering in ground). In this connection, the investigation tentatively estimates (on utilizing, in particular, the findings of Hitashi et al.) the counting rate expected of such an apparatus. The ^{28}Si nucleus was selected for the calculations, since Si is the most common earth element, and the calculations were performed with respect to two incident-muon energies. A formula for the photonuclear interaction cross section was derived from the condition of relativistic and gradient invariance on taking into account the energies of the incident and the scattered muons, respectively. On this basis it is shown that for high energies and large angles the photonuclear interaction makes the principal contribution. The cross sections derived in this manner were used to determine the number of muons passing across 1 cm^2 of horizontal area at sea level per second within the range of angles of from 0 to $\propto$ (the angle 0° corresponds to the upward direction); it is shown that, assuming single scattering, this problem reduces to the calculation of an integral, and that the incident muons with energies of the order of 5 to 10 GeV play the major role. This estimate is tentative; an experiment to measure the number of muons moving toward the upper hemisphere would provide additional information on the photonuclear interaction cross section. (JPRS)

21915 DETERMINATION OF CASCADE PARTICLE–MATTER INTERACTION FUNCTIONS BY THE CONVERSE-PROBLEM METHOD. Astaf'ev, V. A.; Komlyagina, N. N. (Moscow State Univ.). Izv. Akad. Nauk SSSR, Ser. Fiz., 31: 1551-4(Sept. 1967). (In Russian).

The converse problem in cascade theory consists of two stages. In the first stage the moments of the sought function are expressed by cascade characteristics on solving the corresponding integral equations, while in the second stage the function is reproduced according to the derived moments. However, there exist certain physical problems in which each of these stages is separately employed. The investigation deals with two problems of this kind; their solution illustrates the potential and the possibilities of the converse problem. The two problems considered are: (1) extrapolation of mean multiplicity to the high-energy region. This refers to the mean multiplicity of the particles generated by collision with primary-particle nucleus. In this case the determination of the multiplicity under ground-based conditions according to isolated particles is difficult and hence this multiplicity can be, instead, derived from cascade data. (2) Reproduction of differential cross section according to moments: while the differential interaction cross section is a homogeneous function of energy, the integral equations of the converse problem degenerate into algebraic equations. It is shown that in this case the problem of determining the shape of the cross section reduces to the problem of reproducing the function according to its moments. (JPRS)

21916 FLUCTUATION OF NUMBER OF PARTICLES IN THREE-DIMENSIONAL THEORY OF ELECTROMAGNETIC SHOWERS. Gedalin, E. V. (Inst. of Physics, Tbilisi, USSR). Izv. Akad. Nauk SSSR, Ser. Fiz., 31: 1548-50(Sept. 1967). (In Russian).

An electron–photon shower is considered on assuming a specific probability that at depth t in matter a particle will produce a shower with n electrons and ν photons. An equation of the probability function is derived on taking into account only the processes of the bremsstrahlung and elastic scattering of electrons and the formation of pairs by photons (along with ionization losses of electrons). This equation and the succeeding equations are derived on the premise that the particle scattering angles are not too small to disregard the scattering-caused variation in particle path length. Recurrence relations linking the moments of particle number to lower-order moments are derived. In cases where the particle scattering angles are so small that the variation in path length may be disregarded, calculations of mean square numbers of electrons in light substances show that the behavior of $\sigma_1(R)$ entirely resembles the dependence of $\sigma_1(\theta)$ on the angle of deflection of particles from the direction of the shower axis. For showers in heavy elements the behavior of $\sigma_1(R)$ should be qualitatively the same. (JPRS)

21917 EQUILIBRIUM FUNCTIONS OF ANGULAR DISTRIBUTION OF CASCADE ELECTRONS IN IRON AND LEAD. Ivanenko, I. P.; Samosudov, B. E. (Moscow State Univ.). Izv. Akad. Nauk SSSR, Ser. Fiz., 31: 1545-7(Sept. 1967). (In Russian).

A formula for the equilibrium functions of the angular distribution of cascade particles in Fe and Pb is derived on assuming multiple scattering for a shower caused by a particle having the finite energy E_0. Numerical calculations of the angular distribution functions of the total number of particles were performed on an electronic computer for $0 \leq \Theta \leq \pi$. The equation of the distribution function of electrons is presented for a primary electron vertically incident on the material (Fe or Pb), and the solution of this equation is given in the form of a series of Legendre polynomials. It is shown that the small-angle approximation satisfactorily describes the equilibrium angular distribution of cascade particles up to the angles of 10 to 20°. A strong dependence of the angular distribution functions on the primary-particle energy for $\Theta \lesssim 20°$ is demonstrated. When $\Theta \gtrsim 0.1°$ the angular distribution function for $\epsilon_0 \gtrsim 3 \times 10^3$ coincides with the function for $E_0 = \infty$. These findings are in agreement with the findings of Blocker et al. (Phys. Rev., 79, 419 (1950)) on showers in Pb and Cu. (JPRS)

21918 ANGULAR DISTRIBUTION OF ELECTRONS AT VARIOUS DEPTHS IN CASCADE SHOWERS. Guzhavin, V. V.; Ivanenko, I. P.; Potapova, L. N.; Samosudov, B. E. Izv. Akad. Nauk SSSR, Ser. Fiz., 31: 1542-4(Sept. 1967). (In Russian).

Formulas for the angular distribution functions of shower particles at various depths in a layer of matter are derived on assuming multiple scattering in cascade showers with a given primary-particle energy E_0. A second-order differential equation for the energy part of the solution, presented in the form of a series with respect to Legendre polynomials, is derived and the solution of this equation by the method of successive approximations is presented. Thus a correct dependence of the solution on the energy E_0 of the primary particle is derived for the first time. It is shown that this solution coincides with the solution of the problem of the angular distribution of particles propagating in matter without energy losses. (JPRS)

21919 NEGATIVE EXCESS OF ELECTRONS IN ELECTROMAGNETIC CASCADE SHOWERS. Guzhavin, V. V.; Ivanenko, I. P.; Levitin, A. E. (Moscow State Univ.). Izv. Akad. Nauk SSSR, Ser. Fiz., 31: 1538-41(Sept. 1967). (In Russian).

A system of three basic equations for the quantitative calculations of the negative(-charge) excess of electrons in electromagnetic cascade showers is presented. The equations pertain to the one-dimensional cascade theory for the distribution functions of electrons, positrons, and photons with respect to energy over depth of development of the shower, on taking into account the ionization losses and the positron-annihilation effect in the shower with the total energy E_0. The solution is based on the method of successive approximations. It was established that, even when an allowance is made for the ionization losses, the maximum relative difference in the number of electrons and positrons does not exceed 5%. The equations derived do not take into account the processes of generation of recoil electrons and δ electrons. (JPRS)

21920 DEVELOPMENT OF ELECTROMAGNETIC SHOWERS IN LEAD. Emel'yanov, Yu. A.; Lukin, Yu. T.; Amanov, K. A.; Kharitonova, K. S. Izv. Akad. Nauk SSSR, Ser. Fiz., 31: 1536-7(Sept. 1967). (In Russian).

Electromagnetic showers developing in Pb were recorded with the aid of an ionization calorimeter. Eighty-seven events with the total number of recorded particles per shower ranging from 3000 to 4000 were selected and statistically processed on determining the ratio of the number of primary charged particles to the number of neutral particles according to the readings of hodoscopic counters. An averaged experimental curve was plotted and was then compared with theoretically plotted curves. The mean transition factor of the shower was determined in relation to depth of development of the shower and was found to be $k = 2.3 \pm 0.2$. At low depths the value of k was below unity, apparently because at these depths the theoretical curve unsatisfactorily describes the electromagnetic cascade. In the region of values of the parameter $x/x_{max} > 2.0$ (where x_{max} is the position of the maximum) the transition coefficient decreases; so far no explanation for this could be found. (JPRS)

21921 STUDY OF ELECTRON-PHOTON CASCADES IN IRON IN THE ENERGY REGION OF ~10^{12} eV. Borog, V. V.; Kirillov-Ugryumov, V. G.; Petrukhin, A. A.; Shestakov, V. V. (Moscow Engineering-Physics Inst.). Izv. Akad. Nauk SSSR, Ser. Fiz., 31: 1533-5(Sept. 1967). (In Russian).

The radiation unit length for iron was investigated with the aid of electromagnetic cascades from the bremsstrahlung of the muons of a horizontal cosmic-ray flux, obtained in a MIFI ionization calorimeter. Energy analysis of the cascade showers showed that the mean energy of the recorded showers was 760 GeV. Statistical analysis of the findings showed that the mean radiation unit length

for Fe is (14.0 ± 1.6) $g \cdot cm^{-2}$; the error of 1.6 $g \cdot m^{-2}$ represents the square root of the variance of distribution of unit lengths for the individual cascades. It is established that the mean radiation unit length is not significantly affected by variations in such other parameters as the coefficient for the conversion of ionization to particle number and the coefficient k_γ, up to a point. It is shown that the cascade curves satisfactorily describe the development of electromagnetic cascades in Fe for the energy region of ~10^{12} eV. (JPRS)

21922 PROSPECTS FOR THE INVESTIGATION OF PARTICLE INTERACTIONS IN THE ENERGY RANGE OF 10^{13} TO 10^{15} eV. Nikol'skii, S. I. Izv. Akad. Nauk SSSR, Ser. Fiz., 31: 1505-11(Sept. 1967). (In Russian).

The totality of experimental findings on the nuclear-active component of extensive air showers (EAS), on the EAS spectra with respect to particle numbers at various levels of observation and on the energy spectrum of nuclear-active particles and γ quanta implies the existence of an additional process of the transfer of energy to the electron–photon avalanche by nucleons with energies exceeding 4×10^{13} eV; this new process complements the pionization process and the isobaric mechanism of pion production. To verify the existence of the above process, experimental findings on a flux of nuclear-active particles observed with the aid of a neutron monitor in an EAS with a specified number of electrons are compared with the results of calculations that make an allowance for additional energy transfer by nucleons with $E_0 > 4 \times 10^{13}$ eV and for the complex composition of primary cosmic radiation. This new process may be termed "gammaization," since it leads to the generation of four γ quanta at the energies $E_0 \gtrsim 4 \times 10^{13}$ eV · $nucleon^{-1}$. Since all the data on nucleon collisions involving the above energies were obtained in indirect observations, the details of the process of "gammaization" largely remain speculative and require further investigation with respect to cosmic radiation in the super-high-energy region. Analysis of fluctuations of the muon flux in EAS could also be utilized to clarify certain aspects of this new process. (JPRS)

21923 ANALYZING JETS OF SUPER-HIGH-ENERGY PARTICLES IN IMAGES OF VELOCITY SPACE. Bubelev, E. G. Izv. Akad. Nauk SSSR, Ser. Fiz., 31: 1487-90(Sept. 1967). (In Russian).

A new method of analyzing nuclear reactions in images of the Lobachevskii–Einstein velocity space is applied to particle jets with the energy $E_0 \geq 10^{12}$ eV. The method is based on the Lobachevskii longitudinal velocity diagram (L-diagram) as well as on the diagram of doubled transverse half-velocities $2\omega^\perp$ which also contains information on azimuth angles of particle divergence. It is shown that a three-dimensional quasi-Euclidean figure represented by its mutually orthogonal Euclidean "projections"—the L and $\omega^\perp$ diagrams for a given reaction—retains the features of a kinematic figure of the reaction in the velocity space; the latter represents the geometric image of the kinematics of the reaction, which is independent of the reckoning system selected. The kinematic figure for the jet with $E_0 = 10^{12}$ to 10^{14} eV and with a large number of relativistic particles $n_s \geq 20$ to 40 is shown to be cigar-shaped. L and $\omega^\perp$ diagrams are constructed and analyzed for jets with energy E_0 = 20, 1, and 2 TeV. (JPRS)

21924 NUCLEAR-CASCADE AVALANCHES IN IRON. Denisov, E. V.; Kim, M. V.; Morozov, A. E.; Slavatinskii, S. A. Izv. Akad. Nauk SSSR, Ser. Fiz., 31: 1468-9(Sept. 1967). (In Russian).

This work is a continuation of an earlier investigation (Denisov, E. V., et al., Sb. Kosmicheskiye Luchi, 1967 (in print)) and was carried out with the aid of an ionization calorimeter which was triggered whenever the energy released exceeded 100 GeV. Altogether 580 avalanches generated in five upper layers of the Fe absorber were analyzed; 467 of the avalanches were generated by particles with energies of 100 to 300 GeV; 80, with energies of 400 to 800 GeV; and 26, with energies exceeding 800 GeV. An averaged nuclear-cascade curve of $dE/dx = f(x)$ was plotted for each of these energy ranges, where x is the thickness of absorber in $g \cdot cm^{-2}$ and dE/dx is the energy release in $GeV \cdot g^{-1} \cdot cm^2$ at the depth x. On this basis values of absorption path λ_{abs} for the avalanches were derived: $\lambda_{abs} = 220^{+}_{-}$, 300^{+15}_{-}, and 350^{+30}_{-30} $g \cdot cm^{-2}$, respectively, for $\bar{E}_0$ = 200, 500, and 1200 GeV, respectively. Clearly λ_{abs} increases with increase in energy. (JPRS)

21925 REPORT ON THE PERFORMANCE OF THE TSKHRA–TSKARO APPARATUS AND PRELIMINARY FINDINGS ON THE FREE PATCH OF NUCLEAR-ACTIVE PARTICLES WITH THE ENERGY OF 10^{11} TO 10^{12} eV IN CARBON. Andronikashvili, E. L.; Garibashvili, D. I.; Gigalashvili, T. S.; (and others). Izv. Akad. Nauk SSSR, Ser. Fiz., 31: 1455-7(Sept. 1967). (In Russian).

The apparatus for measuring the free path of nuclear-active particles in carbon was put into operation in August 1966 at the Tskhra–Tskaro Mountain Station, 2500 m above sea level. It consists of two 1000-liter Wilson chambers placed in the field of an electromagnet having the intensity of 6000 Oe, an ionization calorimeter, and six arrays of Geiger–Mueller counters. Following certain adjustments this apparatus began to perform satisfactorily and was used to record the passage of penetrating particles through a 38.8 $g \cdot cm^{-2}$ thick carbon generator. During 100 hr of operation of the apparatus (340 frames) 169 transits of penetrating particles across the generator were recorded; of this total 59 interacted in the graphite. This corresponds to a free path length in carbon $\lambda_C = (98 \pm 13)$ $g \cdot cm^{-2}$ and hence also to $\sigma_C = (204 \pm 28)$ mb. (JPRS)

21926 INTERACTION CROSS SECTION OF NUCLEAR-ACTIVE PARTICLES HAVING ENERGIES OF FROM 5 X 10^{10} TO 10^{12} eV IN IRON. Garibashvili, D. I.; Kakauridze, D. B. Izv. Akad. Nauk SSSR, Ser. Fiz., 31: 1458-9(Sept. 1967). (In Russian).

Interaction cross section in iron was determined with the aid of the ionization calorimeter of the Tskhra–Tskaro apparatus; the project was commenced in February 1966 and continued until mid-September. The calorimeter was operated for a total of 1400 hr, during which 5800 events were recorded. The interaction path was determined by the maximum likelihood method with the aid of Bartlett's S function and the determination of the cross section was carried out in the presence of certain constraints (1. Only cases with an explicit direction of line development were selected. 2. Events in which ionization was released in the first bed of the ionization calorimeter were disregarded. 3. Events commencing below the 8th bed of the calorimeter were disregarded. 4. Lateral events were disregarded.) Findings: the interaction path for nuclear-active particles with energies of 5×10^{10} to 10^{12} eV in iron is (126 ± 6) $g \cdot cm^{-2}$, which corresponds to the interaction cross section $\sigma = (738 \pm 37)$ mbarn. Furthermore, within the margin of measurement error, the interaction cross section did not vary with the energy. (JPRS)

21927 CROSS SECTION OF INTERACTIONS OF NUCLEAR-ACTIVE PARTICLES WITH ATOMIC NUCLEI OF LEAD AT THE ENERGY OF 10^{11} eV. Baigubekov, A. S.; Denikaev, R. Z.; Lukin, Yu. T. Izv. Akad. Nauk SSSR, Ser. Fiz., 31: 1453-4 (Sept. 1967). (In Russian).

The cross section of inelastic interaction between cosmic-ray particles and atomic nuclei of Pb in the energy range $E_0 \geq 100$ GeV was determined. To this end, interactions of isolated nuclear-active particles in the absorber shield of a ionization calorimeter were recorded at the height of 3340 m above sea level and the path of interaction of these particles with the atomic nuclei of lead was determined and then used to derive the cross section. Thirty-eight cases of interaction in the lead absorber and 132 cases of interaction in the iron absorber of the calorimeter were analyzed for this purpose. The experimental findings were corrected for energy underestimation and for the adverse effect of the finite thickness of the absorber on the effectiveness of the recording of interactions in the ionization chambers of the calorimeter. The path for interaction in lead was thus found to be $L_{Pb} = (150 \pm 60)$ $g \cdot cm^{-2}$, and the cross section corresponding to this path, $\sigma = (2300 \pm 900)$ mb. (JPRS)

21928 MEASUREMENTS OF EFFECTIVE CROSS SECTION OF INELASTIC INTERACTION BETWEEN PROTONS AND CARBON NUCLEI IN THE ENERGY RANGE OF 10^{10} TO 10^{12} eV BY MEANS OF THE PROTON-1 AND PROTON-2 SPACE PROBES. Basilova, R. N.; Grigorov, N. L.; Nesterov, V. E.; Rapoport, I. D.; Savenko, I. A.; Skuridin, G. A. Izv. Akad. Nauk SSSR, Ser. Fiz., 31: 1450-2(Sept. 1967). (In Russian).

Findings on the statistical processing of data provided by the Proton-1 and Proton-2 space probes are presented. The effective cross sections of inelastic interactions between protons and carbon nuclei were measured by the technique of "knocking-out from the beam," with recording of singly charged particles. It was observed that these cross sections increased in size with increase in energy (221 ± 3 mb at 2.4×10^{10} eV compared with 256 ± 15 mb at 1.1×10^{12} eV). This was confirmed by measurements performed with the aid of accelerators by the same team of experimenters. (JPRS)

21929 MANY-PARTICLE MECHANISM OF THE INTERACTION BETWEEN COSMIC RADIATION AND ATOMIC NUCLEI. Artykov, I. Z.; Barashenkov, V. S.; Eliseev, S. M. Izv. Akad. Nauk SSSR, Ser. Fiz., 31: 1448-9(Sept. 1967). (In Russian).

The mechanism of intranuclear cascades considered as series of successive two-particle interactions results in a sharp deviation from experimental findings at energies of $T \gtrsim 100$ GeV. This

is because theoretical calculations fail to take into account many-particle interactions inside the nucleus, which are particularly essential in the high-energy regions. New calculations which make an allowance for these interactions are presented. The calculations were performed on adopting various assumptions concerning the nature of the angular and energy distributions of the particles generated by many-particle interactions. A good agreement with all experimental photoemulsion findings can be obtained only on assuming that these interactions result in the generation of a leading particle that entrains a major part of all primary energy. The characteristics of the other particles are close to those observed in πN collisions (given correspondingly equal energies in the center-of-momentum system). (JPRS)

21930 ISOBARIC MECHANISM OF GENERATION OF HIGH-ENERGY PIONS IN COSMIC RAYS. Shestoperov, V. Ya.; Chikova, L. O. (Moscow State Univ.). Izv. Akad. Nauk SSSR, Ser. Fiz., 31: 1445-7(Sept. 1967). (In Russian).

The processes resulting in the formation of fast π mesons include the decay of isobaric states of the nucleon; thus e.g., owing to interaction, along with the meson cloud there forms the isobaric excited state of the nucleon. This isobar, in its turn, decays into a nucleon and a π meson. Additional calculations were performed to determine whether the decay of the isobar results in the formation of more than one π meson. These calculations, as well as experimental findings, showed that if high-energy pions are generated by the decay of a heavy isobar into a nucleon and several π mesons then the mass of this isobar must be more than 2.4 to 2.5 times as large as the mass of the nucleon. It is concluded that the earlier assumption that the isobar decays into a nucleon and a single π meson contradicts the experimental findings and that the decay of the isobar, as a rule, results in the formation of least three particles. (JPRS)

21931 CONTRADICTIONS IN RESEARCH INTO HIGH-ENERGY COSMIC-RAY PARTICLES. Grigorov, N. L.; Shestoperov, V. Ya. Izv. Akad. Nauk SSSR, Ser. Fiz., 31: 1442-4 (Sept. 1967). (In Russian).

There exist definite contradictions between the measurements of the energy spectra of nuclear-active particles in the atmosphere at various altitudes and the widespread belief of the energy independence of the interaction inelasticity coefficient k and the interaction path L_{int}. Essentially these contradictions reduce to the following: If the energy spectrum of the primary particles is $N(\geq E) = AE^{-\gamma}$, then for k = const and L_{int} = const in the depth of the atmosphere the nucleon spectrum must be $N(\geq E,x) = B(x)E^{-\gamma}$, where $\gamma_1 = \gamma$, whereas experimental findings indicate that $\gamma_1 > \gamma$. (Most investigators agree that $\gamma = 1.6$ to 1.7, at least within the energy range of $E \lesssim 10^{14}$ eV.) It is shown that these contradictions can be eliminated only by assuming variation in the chemical composition of primary cosmic-ray particles, beginning with the energies of $\sim 10^{12}$ eV, i.e., by assuming that the energy spectra of protons and heavy nuclei differ, being more steep for protons than for the nuclei. A corollary of this assumption would be that the spectra of nuclear-active particles in the atmosphere at every depth are virtually identical within the energy range of $> 5 \times 10^{11}$ eV, and that the flux of the primary protons "jumping across" the atmosphere will decrease to an extent at which it will fit the experimental findings. (JPRS)

21932 INTERACTION BETWEEN HIGH-ENERGY NUCLEONS AND NUCLEI. Gerasimova, N. M. (Moscow State Univ.). Izv. Akad. Nauk SSSR, Ser. Fiz., 31: 1440-1(Sept. 1967). (In Russian).

It is shown that the distance between the maxima in the angular distribution of particles due to the relative motion of systems with symmetrical divergence of each of the newly formed hydrodynamic blobs is determined solely by the difference in the mass of the nucleon and the π meson and by the coefficient α relating to the part of energy entrained by the fastest particle in the first interaction. With increase in the energy of the incident nucleon and the atomic number of the nucleus the probability of the successive hydrodynamic process also increases, owing to the increase in the probability of occurrence of the first central interaction in accordance with the Landau hydrodynamic theory. Thus, central nucleon-nucleus collisions, like peripheral interaction between nucleons, result in the generation of several centers rather than of a single excited system. The jets generated by the nucleon–nucleus collision and having a two-maximum angular distribution of the above kind must be characterized by the presence of a relativistic π meson flying backward in the laboratory coordinate system. In this context, the structural distributions of the jets generated by nucleus–nucleus interactions may be interpreted as the superpositions of two maximum distributions forming in different overlapping channels of nuclei. (JPRS)

21933 CONCERNING ASYMMETRICAL SHOWERS. Rozental', I. L.; Sarycheva, L. I. Izv. Akad. Nauk SSSR, Ser. Fiz., 31: 1437-9(Sept. 1967). (In Russian).

The causes of the asymmetry of the angular distribution of secondary particles observed in LiH have long been debated. Various explanations of this asymmetry have been advanced in the past. It is now shown that the selection of the model of fluctuations plays the decisive role in elucidating this effect. Values of the asymmetry coefficient are derived and compared for the Heisenberg and Fermi–Landau models and shown to be similar, amounting to approximately 0.35 to 0.40. This conclusion has a simple physical meaning: the asymmetry reflects the distribution of the inelasticity coefficients k and the values of k for the forward-moving particles are independent of k for the backward-moving particles. While it is difficult to find a conclusive answer to the question of what is the physical meaning of the experimentally observed marked fluctuations in k, it seems that they are qualitatively predicted by the Landau theory. (JPRS)

21934 PASSAGE OF COSMIC RADIATION THROUGH THE ATMOSPHERE. Erofeeva, I. N.; Murzin, V. S. Izv. Akad. Nauk SSSR, Ser. Fiz., 31: 1434-6(Sept. 1967). (In Russian).

Research into the interactions between pions and nuclei has shown that, in most cases following collision, the pion is "conserved," entraining more than one-half of the initial energy. Then, in approximately one-half or one-third of all cases the primary pion undergoes an inelastic "charge exchange" and turns into a π^0 meson. The remaining energy gets distributed between several low-energy pions. On this basis it is assumed that a charged or neutral pion entraining about two-thirds of the initial energy participates in every event. The calculations also were performed for the case where this energy is divided in half between two secondary pions. If it is assumed to a first approximation that the distribution of high-energy ions may be represented by a δ function, the kinetic equations of the nuclear-cascade process can be analytically solved to derive the intensity of nucleons, pions, and photons at various depth, provided that the primary spectrum of the nucleons is known. The conversion from the burst energy to the energy of the primary particle is based on a coefficient of 4.4 at the depth of 200 $g \cdot cm^{-2}$ and 2.9 at the depth of 70 $g \cdot cm^{-2}$. This theoretically and experimentally observed difference in the conversion coefficient can be explained only by the effect of the pions. (JPRS)

21935 STUDY OF THE INTERACTIONS OF NUCLEONS HAVING THE ENERGY OF $\sim 10^{14}$ eV. Apanasenko, A. V.; Baradzei, L. T.; Kanevskaya, E. V.; Rykov, V. V.; Smorodin, Yu. A.; Solov'ev, M. V. Izv. Nauk SSSR, Ser. Fiz., 31: 1431-3 (Sept. 1967). (In Russian).

Nucleon interactions were investigated by means of aircraft-borne apparatus at altitudes of 10 and 12 km. The obtained x-ray films displayed 600 traces of γ quanta with the energy $\geq 6 \times 10^{11}$ eV. Processing of the x-ray photographs revealed that 160 single and 40 pairs of γ quanta with energies of more than 10^{12} eV, as well as 28 families of more than 3 γ quanta each, were recorded. The energy of the γ quanta was photometrically determined. It is established that currently employed techniques are not accurate enough to make an allowance for the contribution of the processes of generation of a single γ quantum to the formation of the spectrum of γ quanta in the atmosphere. The ratio of the number of γ quanta in the pairs to the number of γ quanta in the families roughly equals unity for energies of up to $\sim 2 \times 10^{12}$ eV. The energy distribution of the electron–photon components over an area of 8 m^2 (overall area of the array of Cherenkov counters) was established with respect to the high-energy events recorded by x-ray films. (JPRS)

21936 STUDY OF HIGH-ENERGY γ QUANTA GENERATED IN NUCLEAR INTERACTIONS. Babayan, Kh. P.; Marutyan, N. A.; Mitoyan, S. V. Izv. Akad. Nauk SSSR, Ser. Fiz., 31: 1428-30 (Sept. 1967). (In Russian).

Experimental findings on the characteristics of the high-energy γ quanta generated during interaction of particles having the energy $E_0 \gtrsim 1.5 \times 10^{12}$ eV with the nuclei of atoms of carbon and air (particles of graphite filter), as investigated by the calorimeter method at the Mt. Aragats Station, are presented. 13 instances of such interactions were analyzed. In addition, the photographic plates exposed without a graphite filter revealed three super-high-energy families of electron–photon cascades; analysis of these cases points to their simultaneity and hence also common origin. During the same period (June–July 1964) a case corresponding to an extensive air shower with the energy $E_0 \gtrsim 4.0 \cdot 10^{14}$ eV was recorded; the direction of its axis could be precisely established. It is postulated that the families of electron–photon cascades originated from the γ quanta of the decay of π^0 mesons in three individual interactions between the nuclear-active component of the extensive air shower and the nuclei of air. (JPRS)

21937 ENERGY SPECTRUM OF NUCLEAR-ACTIVE PARTICLES AT ALPINE HEIGHTS. Babayan, Kh. P.; Boyadzhyan, N. G.; Grigorov, N. L.; Mamidzhanyan, E. A.; Sobinyakov, V. A.; Tret'yakova, Ch. A.; Shestoperov, V. Ya. Izv. Akad. Nauk SSSR, Ser. Fiz., 31: 1425-7(Sept. 1967). (In Russian).

Experimental findings on measurements of ionization bursts performed at the Aragats Alpine Station (3200 m above sea level) are presented. The measurements were carried out with the aid of two setups, one consisting of six arrays of ionization chambers and composite lead/graphite filters and the other represented by a ionization calorimeter consisting of 12 arrays of ionization chambers and Pb/graphite/iron filters. The spectrum of ionization bursts recorded by the individual chambers was tentatively converted to the energy spectrum of the nuclear-active particles that had caused these bursts. The integral spectrum of the nuclear-active particles at the height of 3200 m above sea level was obtained with the aid of the ionization calorimeter. Altogether 3194 bursts of a magnitude of $N \geq 4.3 \times 10^3$ rel. particles were recorded in individual chambers of the chamber array located under the upper filter. (JPRS)

21938 MEASUREMENT OF THE PART OF ENERGY TRANSMITTED TO π^0 MESONS IN THE PRESENCE OF ENERGIES OF HUNDREDS OF GeV. Morozov, A. E.; Slavatinskii, S. A.; Fetisov, I. N. Izv. Akad. Nauk SSSR, Ser. Fiz. 31: 1423-4(Sept. 1967). (In Russian).

This work is a continuation of a previous investigation (Guseva, V. V., et al., Izv. Akad. Nauk SSSR, Ser. Fiz., 30: 1574 (1966)) dealing with the measurement of the part of the energy $K_{\pi^0} = E_{\pi^0}/E_0$ transmitted to neutral pions during interactions with heavy nuclei. The investigation was performed with the aid of an ionization calorimeter at the Tyan'-Shan' Mountain Station. Ninety events within the energy range of 100 to 500 GeV were selected for analysis. The energy transmitted to π^0 mesons in the first act of interaction was measured according to the development of the electron–photon cascade in the lead absorber. Curves of ionization in relation to thickness of the lead absorber were plotted. The derived distribution of the inelasticity coefficient K_{π^0} for the mean $\langle K_{\pi^0} \rangle = 0.35$ satisfactorily fits the mean derived from the averaged cascade curve so long as no allowance is made for the secondary interactions. Thus the contribution of secondary interactions (including nuclear splittings) could not be effectively established in individual cases with respect to four series in lead. (JPRS)

21939 CERTAIN FINDINGS OBTAINED BY THE METHOD OF CONTROLLABLE NUCLEAR PHOTOEMULSIONS WITH TIME RECORDING OF REGISTRABLE EVENTS. Grigorov, N. L.; Brikker, S. I.; Podgurskaya, A. V.; Savel'eva, A. I.; Sobinyakov, V. A.; Shestoperov, V. Ya. Izv. Akad. Nauk SSSR, Ser. Fiz., 31: 1420-2(Sept. 1967). (In Russian).

High-energy nuclear interactions were investigated at the Agarats Mountain Station (3200 m above sea level) by exposing nuclear photoemulsions and x-ray film with the aid of a specially designed setup equipped with a timer for recording energies of $\geq 5 \times 10^{11}$ eV and on using a special technique for the identification of showers in photoemulsions and analysis of operating time of the setup. Recently a new class of events apparently occurring in the setup has been discovered; they pertain to instances of low air resistance. A single high-power electron–photon shower column was observed. The energy of the γ-quantum creating this shower in lead is 1 to 3×10^{12} eV. Eight instances of this kind were observed. The investigation is continuing, with the object of obtaining additional data warranting an interpretation of these events. The setup is also used to investigate extensive air showers. (JPRS)

21940 ZENITHAL ANGULAR DISTRIBUTION OF CHARGED NUCLEAR-ACTIVE PARTICLES WITH MEAN ENERGIES EXCEEDING 60 GeV. Kavlakov, Sht.; Betev, B.; Fen'vesh, E.; Bozoki, G. (Physics Inst., Sofia. Central Physics Inst., Budapest). Izv. Akad. Nauk SSSR, Ser. Fiz., 31: 1417-19(Sept. 1967). (In Russian).

The distribution of charged nuclear-active particles with mean energies of the order of 60 GeV was experimentally investigated with respect to zenith angle on the basis of the photographic records of the hodoscopic counter installation operated at the Cosmic-Ray Station of the Bulgarian Academy of Sciences on Mt. Musala ($\lambda = 23°35'$ E.; $\phi = 42.11'$ N; height 2925 m above sea level). The experimentally obtained values of $\Delta N(\alpha)$ for 12 different angles α were substituted in the formula of angle intervals. The resulting system of equations was processed by the maximum likelihood method. On the premise of a Poisson distribution of events the value of m (i.e. of the λ/h ratio) was found to be 8.1 ± 0.3 correct to the second order of magnitude. This finding does not contradict the value of m derived by other authors. (JPRS)

21941 ANGULAR DISTRIBUTION OF SHOWER PARTICLES IN HIGH-ENERGY INTERACTIONS. Babaev, M. K.; Eremenko, Yu. A.; Lukin, T. Yu.; Machekhin, A. M.; Takibaev, Zh. S. Izv. Akad. Nauk SSSR, Ser. Fiz., 31: 1409-11(Sept. 1967). (In Russian).

Interaction between cosmic-ray particles and atomic nuclei of carbon was investigated by using a setup consisting of a Wilson chamber, an ionization calorimeter, and arrays of hodoscopic counters. In 160 days 40 interactions between nuclear-active particles and nuclei of graphite and Cu were recorded. Angular distribution for the showers formed in graphite could be represented by a gaussian curve. The number of observed asymmetric showers was somewhat higher than could be explained by fluctuations in the distribution of secondary particles; this is probably attributable to the presence of nonnucleon–nucleon interactions, on proceeding from the premise that all the secondary particles are π-mesons having $p_\perp = 0.4$ GeV/c. (JPRS)

21942 STORAGE AND DIFFUSION OF COSMIC-RAY ELECTRONS IN THE GALAXY. Jokipii, J. R.; Meyer, Peter (Univ. of Chicago). Phys. Rev. Lett., 20: 752-4(Apr. 1, 1968).

The propagation of cosmic-ray electrons in the galaxy and the effects of attendant energy loss are discussed. It is shown that previous discussions, based on the concept of a "leakage lifetime" T_L, are misleading and a more satisfactory approach is briefly discussed. (M.O.W.)

21943 COSMIC-RAY ELECTRON SPECTRUM ABOVE 50 BeV AND ITS IMPLICATIONS FOR COSMIC-RAY CONFINEMENT. Anand, K. C.; Daniel, R. R.; Stephens, S. A. (Tata Inst. of Fundamental Research, Bombay). Phys. Rev. Lett., 20: 764-8(Apr. 1, 1968).

Measurements are reported of the electron flux between 50 and 300 GeV, based on 49 events recorded in nuclear emulsions exposed over Hyderabad, India. The data are discussed. (M.O.W.)

21944 ARE ALL COSMIC-RAY MUONS REALLY MUONS? Callan, C. G. Jr.; Glashow, S. L. (Harvard Univ., Cambridge, Mass.). Phys. Rev. Lett., 20: 779-80(Apr. 1, 1968).

The existence of a new component of cosmic radiation is proposed to explain the recent discovery that cosmic rays found in deep mines do not satisfy the "secθ law." This component must make up about one thousandth of the primary flux and must consist of stable, massive, charged particles without strong interactions. (M.O.W.)

21945 ACTIVATION OF COSMIC DUST BY COSMIC-RAY PARTICLES. Lal, D.; Venkatavaradan, S. (Tata Inst. of Fundamental Research, Bombay). Earth Planet. Sci. Lett., 3: 299-310(Jan. 1968).

The magnitude of isotopic changes induced in cosmic dust, due to nuclear interactions of solar and galactic cosmic rays, is calculated for several radioisotopes which seem suitable as signatures of cosmic dust in terrestrial environments. The rates of accretion of these radioisotopes depend on the composition and size distribution of cosmic dust, in addition to the cosmic dust mass influx rate, and the flux of low-energy particle radiation in space. The monitor radioisotopes are produced efficiently only in dust grains of certain preatmospheric size intervals; this is discussed separately for the monitor radioisotopes considered. (auth)

21946 STUDIES OF SUPERHEAVY NUCLEI IN COSMIC RAYS. Volodichev, N. N.; Grigorov, N. L.; Savenko, I. A. Kosm. Issled., 5: 431-5(May-June 1967). (In Russian).

The results of a study of the chemical composition and energy spectra of cosmic rays in the area of nuclear charge $Z \gtrsim 30$, carried out by means of a Cherenkov spectrometer on the Proton-1 and Proton-2 space vehicles, are reported. (tr-auth)

21947 STUDY OF THE ENERGY DISTRIBUTION OF COSMIC-RAY PARTICLES WITH DIFFERENT MASSES ON PROTON-1 AND PROTON-2. Volodichev, N. N.; Grigorov, N. L.; Savenko, I. A. Kosm. Issled., 5: 436-41(May-June 1967). (In Russian).

The results of a study of the spectra and rigidity of nuclei in the charge interval $Z \geq 2$ to 21 by means of a Cherenkov spectrometer are reported. (tr-auth)

21948 SIDEREAL DIURNAL VARIATION OF COSMIC RAYS. Dorman, L. I.; Inozemtseva, O. I.; Ilgach, S. F.; Mazaryuk, E. A. Izv. Akad. Nauk SSSR, Ser. Fiz., 31: 1357-9(Aug. 1967). (In Russian).

The sidereal diurnal wave was observed throughout the latest solar activity cycle (1953–1964) for particles with energies of from 10^{10} to 10^{17} eV. The first techniques of isolating sidereal diurnal variations have not been sufficiently effective, however, since they do not make sufficient allowance for modulation ef-

fects. Subsequent research has shown that the annual modulation of diurnal variation is of a complex nature and may markedly distort the observed sidereal diurnal wave. It may be conditioned by at least three factors: seasonal fluctuations in temperature of the atmosphere; geometric effects associated with the position of the Earth and Sun relative to one another; and asymmetric flow of the solar wind with respect to the helioequator. If the depth and phase of the amplitude and phase modulation over a given period are known, spurious sidereal diurnal variations can be detected and eliminated. On the whole, however, the methods of determining the modulation parameters with the object of detecting the presence of true sidereal diurnal variation for particles with the energies of 10^{10} to 10^{17} eV are so far insufficiently precise, and hence also the very question of the presence of a true sidereal diurnal variation remains open for particles with the above energies. (JPRS)

21949 SIDEREAL DIURNAL VARIATIONS CONDITIONED BY THE MODULATION OF COSMIC RAYS. Krymskii, G. F.; Altukhov, A. M.; Krivoshapkin, P. A.; Kuz'min, A. I.; Chirkov, N. P. (Inst. of Cosmophysics Research and Aeronomy, Yakutsk, USSR). Izv. Akad. Nauk SSSR, Ser. Fiz., 31: 1360-1(Aug. 1967). (In Russian).

It is shown that sidereal diurnal variations, which correspond to the distribution of cosmic rays in a coordinate system fixed with respect to the stars, display specific properties, on the premise that the distribution of cosmic rays in the "solar heliographic" coordinate system is constant throughout the year and is expressed by the vector $A = A_1 + A_2$, where $A_1 = \{r_1^1, r_1^1, 0, \ldots\}$; $A_2 = \{0, 0, r_2^1, r_2^1, r_2^2, \ldots\}$. This assumption is tantamount to the assumption of stationariness of the mechanism responsible for the first A_1 and second A_2 spherical harmonics. If the distribution is represented in an equatorial coordinate system then the sidereal diurnal variation is expressed directly in terms of local sidereal time. The conversion to the equatorial coordinate system is accomplished in three stages: solar heliographic; sidereal heliographic; and sidereal geographic–equatorial. If the maximum time for an observed sidereal diurnal variation is 7 (for the Earth's southern hemisphere) or 19 hr (for the Earth's northern hemisphere) the variation probably had arisen within the solar system. (JPRS)

21950 SIDEREAL DIURNAL VARIATIONS OF COSMIC RAYS. Kolomeets, E. V.; Nemolochnov, A. N. (Kazakh State Univ., Alma-Ata, USSR). Izv. Akad. Nauk SSSR, Ser. Fiz., 31: 1362-4(Aug. 1967). (In Russian).

The anisotropy of cosmic rays with respect to sidereal time was analyzed on the basis of the data of an azimuth telescope corrected for barometric pressure; the temperature effect was taken into account in the data on various directions. Analysis of the values of diurnal variation in solar time and in sidereal time from the directions of east, north, west, and south revealed that in solar time from the west and south directions the amplitude of the variations is markedly smaller and the maximum time is displaced toward earlier hours. Unless this is a temperature effect (i.e., conditioned by the temperature of the atmosphere), this interesting phenomenon may provide additional information on the source of solar diurnal variation. It is established that the anisotropy in both sidereal and solar time exceeds the margin of error and there is no appreciable correlation between the amplitude of anisotropy in solar and sidereal time; this points to the reality of the anisotropy in sidereal time. Sidereal diurnal variation exists in various years of solar activity, as indicated by experimental underground (40 and 60 MW(e)) data for London, Budapest, and Hobart, which also show that the data for the southern hemisphere specify a sharply different maximum time. (JPRS)

21951 ISOLATING THE TRUE FLUCTUATIONS OF DIURNAL VARIATION. Krymskii, G. F.; Kuz'min, A. I.; Altukhov, A. M. (Inst. of Cosmophysics Research and Aeronomy, Yakutsk, USSR). Izv. Akad. Nauk SSSR, Ser. Fiz., 31: 1365-7(Aug. 1967). (In Russian).

The amplitude and phase distribution of the diurnal variation in the intensity of cosmic rays were analyzed on the premise of the existence of a true diurnal variation. Formulas for deriving the distribution of the vector of diurnal variations and the characteristic function of the vector are presented. It is shown that the distribution of the vector represents an inverse Fourier transform of the characteristic function. On this basis formulas for the amplitude and phase distribution are derived. A comparison of the curves plotted on the basis of these formulas with the curves plotted from experimental findings will make it possible to determine the magnitude of the true fluctuations of the vector of the diurnal (or semidiurnal) variation. (JPRS)

21952 UTILIZATION OF MATRICES IN RESEARCH INTO THE DISTRIBUTION OF COSMIC RAYS. Krymskii, G. F.; Altukhov, A. M.; Krivoshapkin, P. A.; Kuz'min, A. I.; Chirkov, N. P. (Inst. of Cosmophysics Research and Aeronomy, Yakutsk, USSR). Izv. Akad. Nauk SSSR, Ser. Fiz., 31: 1381-3(Aug. 1967). (In Russian).

The distribution of variations in the intensity of cosmic rays may be represented by a series of spherical functions. Its calculation is simpler if the expansion coefficients a_n^m, b_n^m are specified in a definite sequence and represented by components of the multivariate vector A. Then each instrument for the recording of cosmic rays may be represented by the receiving vector R with components x_n^m, y_n^m such that the intensity observed by the instrument is determined as the scalar product $I = R \cdot A$. The distribution may be still more simplified by selecting a physically appropriate coordinate system. In this connection it is important to know how the vectors A and R get transformed on conversion from one spherical coordinate system to another. The transformation of the vectors A and R is linear, since the principle of the distribution of super positions must be observed, and hence a definite matrix M corresponds to this transformation. This matrix is quasi-diagonal and decomposes into a series of matrices corresponding to the transformation of the first, second, etc., spherical harmonics. In this connection a model of the distribution of cosmic rays associated with the presence of regular magnetic-field tubes of force in the interplanetary space is analyzed and it is shown that knowledge of the components r_2^1 and r_2^2 of vector A of the terrestrial coordinate system makes it possible to determine the spatial orientation of the interplanetary magnetic field. (JPRS)

21953 POSITION OF THE COSMIC-RAY EQUATOR DURING 1956–1963 IN THE REGION OF THE ZEROTH MERIDIAN. Dubinskii, Yu.; Khaloupka, P. (Univ. of Kosice, Czechoslovakia). Izv. Akad. Nauk SSSR, Ser. Fiz., 31: 1384-6(Aug. 1967). (In Russian).

The position of the cosmic-ray equator in the region of zero meridian was measured enroute from the Antarctic in May 1963 along an itinerary intersecting the Atlantic Ocean north of Capetown as far as Northern Ireland. The itinerary intersected the magnetic equator at sites with a marked difference between the position of the magnetic and the cosmic-ray equators. The measurements were carried out with the aid of a wide-angle counter telescope. The curves plotted on this basis display a minimum that coincides with the cosmic-ray equator at zero meridian; a smooth curve plotted by the method of least squares was also plotted and its minimum determined. On this basis it is concluded that the possible variations in the cosmic-ray equator in that region during 1956 until 1963, i.e., between a maximum and a minimum of solar activity, lie within the margin of accuracy of the measurements. The region in which the measurements were carried out (from Lat. 30°S to Lat. 40°N) is favorable to studies of this kind (owing to the marked difference between the positions of the geomagnetic and cosmic-ray equators) and hence it may be assumed that the modulation due to the solar wind does not markedly influence the trajectories of cosmic-ray particles. (JPRS)

21954 LATITUDINAL DISTRIBUTION AND COUPLING COEFFICIENTS FOR THE NEUTRON AND TOTAL IONIZING COMPONENTS OF COSMIC RADIATION. Dorman, L. I.; Kovalenko, V. A.; Milovidova, N. P. (Inst. of Terrestrial Magnetism, Ionosphere, and Radio Wave Propagation, Moscow. Inst. of Terrestrial Magnetism, Ionosphere, and Radio Wave Propagation, Leningrad). Izv. Akad. Nauk SSSR, Ser. Fiz., 31: 1387-9(Aug. 1967). (In Russian).

The article presents the results of latitudinal measurements of the intensity of secondary cosmic-ray components in the range of cutoff rigidities R = 0.5 to 10 BV, performed with the aid of RK-1 radio sondes, a neutron monitor, and a crossed telescope that measured the total ionizing and hard components in the vertical direction as well as in the directions of 33 and 55° with respect to the vertical for the azimuths N, S, W, E. The measurements in the stratosphere confirmed that the inertia of the modulation mechanism of 11-year variations is markedly greater for low-energy particles. Over the 11-year period curves of the coefficients of coupling between primary and secondary cosmic-ray variations for the neutron component differ in the region of R < 5 BV, apparently because in 1956 the solar activity level rose markedly compared with the 1954 minimum. The coupling coefficients for the neutron component at the mountain level are derived from their counterparts at sea level and from the known dependence of the barometric coefficient on the rigidity of geomagnetic cutoff and on altitude. (JPRS)

21955 EAST-WEST ASYMMETRY EFFECT IN COSMIC RAYS ACCORDING TO CROSSED-TELESCOPE MEASUREMENTS IN 1965. Dorman, L. I.; Kovalenko, V. A.; Milovidova, N. P. (Inst. of Terrestrial Magnetism, Ionosphere, and Radio

Wave Propagation, Leningrad. Inst. of Terrestrial Magnetism, Ionosphere, and Radio Wave Propagation, Moscow). Izv. Akad. Nauk SSSR, Ser. Fiz., 31: 1390-2(Aug. 1967). (In Russian).

On the basis of the data of the 1965 Latitudinal Expedition of the Siberian Institute of Terrestrial Magnetism, Ionosphere, and Radio Wave Propagation, it was established that the latitudinal course of the intensity of the hard and total ionizing components of cosmic rays is greater for west than for east; this east–west asymmetry effect is determined from the formula $K = 2(I_W - I_E)/(I_W + I_E)$. It was established that K decreases with increase in geomagnetic latitude, because with approach to the poles the angle between the trajectory of a particle moving in the vertical plane and the magnetic lines of force decreases and the deflecting effect of the magnetic field diminishes. This decrease in K with increase in geomagnetic latitude λ is more pronounced for the hard component than for the total ionizing component, probably because the hard component is formed by primary particles with higher energies, which display a smaller east–west asymmetry. At sea level K = 5 to 6% whereas in the stratosphere K = 50 to 60%; the coupling coefficients in the region of cutoff rigidities $R_W - R_E$ differ by nearly one order of magnitude in measurements of the ionizing component at sea level and in the stratosphere. (JPRS)

21956 ANOMALOUS BEHAVIOR OF THE DIURNAL VARIATION OF COSMIC RAYS CLOSE TO THE SOLAR ACTIVITY MINIMUM. Fedchenko, K. K. (Polar Geophysics Inst., Kola, USSR). Izv. Akad. Nauk SSSR, Ser. Fiz., 31: 1355-6(Aug. 1967). (In Russian).

The behavior of the solar diurnal variation of the hard component of cosmic rays during the period from December 1952 to June 1955 (which includes the deep 1954 minimum of solar activity) is investigated according to data from Tikhaya Polar Station obtained with the aid of an ASK-2 shielded ionization chamber. By means of harmonic analysis and averaging successive mean annual seasonal (mid-season) vectors of diurnal variation were derived. The contribution of the temperature effect was analyzed on the basis of the data on aerological observations at 10 polar stations and the diurnal wave of meson intensity of temperature origin was then calculated separately for each season. It is shown that with approach to solar activity minimum there occurs a decrease in the amplitude of the mean annual vector of diurnal variation of the hard component at Tikhaya and the time of maximum is displaced to earlier hours, and further that the temperature effect of the atmosphere is the principal factor responsible for the anomalous behavior of diurnal variation at Tikhaya; once an allowance is made for this factor, the observed amplitude of diurnal variation increases and the range of phase displacement shortens. (JPRS)

21957 ANNUAL MODULATION OF THE AMPLITUDE OF DIURNAL VARIATIONS IN COSMIC RAYS OWING TO GEOMETRICAL FACTORS. Dorman, L. I.; Fisher, S. (Inst. of Terrestrial Magnetism, Ionosphere, and Radio Wave Propagation, Moscow. Moscow State Univ.). Izv. Akad. Nauk SSSR, Ser. Fiz., 31: 1352-4(Aug. 1967). (In Russian).

Modulation of the amplitude of solar diurnal variation is due to the inclination of the Earth's axis of rotation in the plane of the ecliptic and is complemented by the annual wave due to the inclination of the plane of the ecliptic with respect to the helioequator. In this connection, ratios between mean monthly first-harmonic amplitudes of diurnal variation of the neutron component of cosmic rays at Mawson and Churchill stations were investigated in order to find the annual modulation of amplitude of solar-diurnal variation and to preclude the effect of variation in power source, on the premise that the anisotropy source has a specific geometrical shape, namely, that the anisotropy decreases from maximum to zero in accordance with the cosine law (in one hemisphere). Then owing to the inclination of the Earth's axis of rotation to the ecliptic and modulation of diurnal variation at the Mawson and Churchill stations will be in counterphase. Harmonic analysis shows that a distinct annual modulation of the Mawson/Churchill amplitude ratios exists; the modulation reaches its maximum in the first half of December and amplitudes of about 20 and 35%, respectively, during the years of high and low solar activity, respectively. If an allowance is made for the inclination of the ecliptic plane to the helioequator, the modulation amplitude may be modified, but this will not markedly modify the phase, since the Earth intersects the plane of the helioequator on approximately 6 June and 7 December. (JPRS)

21958 POWER DISTRIBUTION OF THE SOURCE OF SOLAR DIURNAL VARIATION OF COSMIC RAYS WITH RESPECT TO PLANE OF THE ECLIPTIC AS A FUNCTION OF SOLAR ACTIVITY. Dorman, L. I.; Fisher, S. (Inst. of Terrestrial Magnetism, Ionosphere, and Radio Wave Propagation, Moscow. Moscow State Univ.). Izv. Akad. Nauk SSSR, Ser. Fiz., 31: 1349-51(Aug. 1967). (In Russian).

Data on the observation of the neutron component of cosmic rays at the Mawson (Lat. 67.6° S; Long. 62.9° E) and Churchill (Lat. 58.8° N; Long. 94.1° W) Stations, both at sea level, were analyzed in order to plot the actual distribution of the source power for solar diurnal variation. The ratios between the first-harmonic amplitudes of diurnal variation of the neutron component were determined for the two stations; the findings indicate that the axis of anisotropy approaches the helioequator with decrease in solar activity, whereas during years of high solar activity it recedes northward from the equator. Taking at 25 BV the effective rigidity of the corpuscles causing diurnal radiation, it is concluded that during 1957–1959 the inclination of the axis of anisotropy to the helioequator was 14 ± 2° (northward); during 1960–1962, 10 ± 2°; and during 1963–1964 the axis was more or less in the plane of the helioequator (0 ± 3°). Thus the spatial distribution of source power stands in a definite relationship to the heliocentric coordinates and the effect of solar activity in the northern and southern hemispheres of the Sun on the processes occurring in interplanetary space is dissimilar; this last results in an asymmetric distribution of source power. (JPRS)

21959 BEHAVIOR OF DIURNAL VARIATIONS DURING MAGNETIC STORMS. Pankratov, A. K.; Stepanyan, A. A. (Crimean Astrophysical Observatory, Moscow). Izv. Akad. Nauk SSSR, Ser. Fiz., 31: 1346-8(Aug. 1967). (In Russian).

This behavior is analyzed on the basis of data provided by neutron monitors and meson telescopes, on plotting time curves of the mean first-harmonic vector of diurnal anisotropy during magnetic storms of types I and II (for type I the amplitude maximum is observed following the sudden commencement (SC) of the magnetic storm, and for type II, prior to the sudden commencement). It is established that in both cases the Earth shifts from the region of low v/D (where v is the velocity of solar wind, D is the diffusion coefficient) to the region of high v/D. When, however, the diurnal K_p index prior to the SC moment of the storm exceeds 22 a sharp decrease in amplitude is observed prior to SC and the vector of additional anisotropy is directed away from the Sun. The behavior of diurnal anisotropy is chiefly determined by the variations in the additional flux of the anisotropy of cosmic rays which, in its turn, is associated with the K_p index and the sector structure of the interplanetary magnetic field. Analysis of the course of hardness of the spectrum of diurnal variation during magnetic storms does not conclusively establish the existence of a difference in the hardness of the stationary and the additional fluxes of anisotropy. (JPRS)

21960 SOLAR DIURNAL VARIATIONS AND SUDDEN CHANGES IN THE INTENSITY OF COSMIC RAYS. Alaniya, M. V.; Dorman, L. I.; Shatashvili, L. Kh. (Inst. of Geophysics, Tbilisi, USSR. Inst. of Terrestrial Magnetism, Ionosphere, and Radio Wave Propagation, Moscow). Izv. Akad. Nauk SSSR, Ser. Fiz., 31: 1343-5(Aug. 1967). (In Russian).

Data on the neutron component of cosmic rays obtained at the Climax and Norikura mountain stations were used to investigate the relationship between solar diurnal variations and sudden changes in the intensity of cosmic rays for various epochs of the 11-year cycle of solar activity. The harmonic coefficients of solar diurnal variations were calculated in every case. It was established that a definite relationship exists between the amplitude and phase of diurnal variation and the sudden changes in the intensity of cosmic rays. The amplitude of a "perturbed" diurnal variation is 1.5 to 2.5 times as large as the amplitude of a "quiet" diurnal variation. On dividing the instances of solar diurnal variations into three classes: "perturbed," "moderate," and "quiet" it was observed that the seasonal course of the phase is most distinct for the "perturbed" variations although it also applies to the other types of diurnal variation. The finding that a close relationship exists between sudden changes in the intensity of cosmic and solar diurnal variations may be regarded as an additional argument in favor of the assumption that sudden changes in the intensity of cosmic rays occur owing to modulation in interplanetary space. (JPRS)

21961 ANNUAL COSMIC-RAY VARIATIONS AND THEIR RELATION TO ACTIVE FORMATIONS ON THE SUN. Dorman, L. I.; Luzov, A. A.; Mamrukova, V. P. (Inst. of Terrestrial Magnetism, Ionosphere, and Radio Wave Propagation, Leningrad. Inst. of Terrestrial Magnetism, Ionosphere, and Radio Wave Propagation, Moscow). Izv. Akad. Nauk SSSR, Ser. Fiz., 31: 1368-71(Aug. 1967). (In Russian).

Owing to the noncoincidence between the Earth's orbital plane and the plane of the solar equator, the Earth's annual motion around the Sun must result in variation of the recorded intensity of cosmic rays. In fact, annual variations of this kind have been discovered in the neutron and hard components of cosmic rays according to the data of the worldwide network for 1960. It turned

out that the gradient of cosmic-ray intensity in the plane perpendicular to the plane of the solar equator is 1.3 to 1.1% per 0.1 A.U. In this connection the effect of solar active formations on the observed structure of the interplanetary magnetic field was investigated. Coefficients of correlation between the annual variations in the neutron component of cosmic rays and the characteristics of active solar formations for individual latitudinal belts of the northern and southern hemispheres of the Sun were calculated, and it was established that: (a) the characteristics of solar activity, including the intensity of the coronal line, point to a negative correlation with the annual variation of cosmic rays; (b) the location of active formations on the Sun that give the maximum values of the correlation coefficient is limited by the coronal zone. A high correlation between the intensities of the neutron and hard components is established; this confirms the modulation nature of the annual variation. (JPRS)

21962 COMPOSITION OF PRIMARY COSMIC RADIATION. Kurnosova, L. V. (Lebedev Inst. of Physics, Moscow). Izv. Akad. Nauk SSSR, Ser. Fiz., 31: 1214-21(Aug. 1967). (In Russian).

Compared with the relative abundance of elements throughout the Universe, cosmic rays contain a higher proportion of heavy nuclei; they also contain a higher proportion of the light nuclei Li, Be, B which exist in negligibly small proportions throughout the Universe. Assuming that the light nuclei Li, Be, B appeared as a result of fragmentation, the quantity of matter traversed by cosmic rays (for the diffusion model of the abundance of elements) may be estimated at 3 $g \cdot cm^{-2}$. A study of the isotopic composition of primary cosmic rays can provide additional information on the abundance of isotopes in interstellar space. Thus, like the nuclei Li, Be, B, certain isotopes normally are not abundantly encountered but may occur in cosmic rays owing to fragmentation during their passage across the interstellar medium. In this context, the information on the generation of the nuclei ^3He, ^{10}Be and deuterium in cosmic rays is of major interest. Recent artificial-satellite data indicate that the type of the energy spectrum in the energy range of from 30 to 100 MeV-nucleon^{-1} differs markedly for α particles and heavy nuclei, being much flatter for heavy nuclei such as boron, carbon, oxygen and nitrogen; this may possibly be attributed to the presence of a quantity of incompletely ionized multiply charged nuclei. The latest findings on cosmic-ray generation during chromospheric solar flares indicate that on the Sun there exists an acceleration mechanism resulting in this generation. The volume of recorded information on the electronic component of primary cosmic rays has in the last few years markedly increased, and it indicates that negatively charged electrons ($\eta \approx 0.30 - 0.80$) account for the greater part of this component and hence also that the products of the disintegration of $\pi^{\pm} \rightarrow \mu^{\pm} \rightarrow e^{\pm}$ make a small contribution to this component. Measurements of the relation of the galactic electron fluxes and type of spectrum to the degree of solar activity would help elucidate the question of whether the energy dependence of modulation is determined by the velocity or the hardness of the particles. Further research on electrons of solar origin is needed, along with research into x and γ radiation, in order to come closer to solving the question of the sources of cosmic rays. (JPRS)

21963 ELECTRON ENERGY SPECTRUM IN THE FLUX OF GALACTIC COSMIC RAYS. Rubtsov, V. I.; Zatsepin, V. I. (Lebedev Inst. of Physics, Moscow). Izv. Akad. Nauk SSSR, Ser. Fiz., 31: 1233-6(Aug. 1967). (In Russian).

Measurements of electron intensity with the aid of specially designed arrays of scintillators lofted into the stratosphere to an altitude of 32 km provided data that were used to plot the curve of the differential energy spectrum of electrons, which showed that in the energy range of from 3.5 to 80 BeV the differential spectrum may be represented as $dN/dE = (125 \pm 20)\ E^{-3.0 \pm 0.3}$ electrons-m^{-2}-sec^{-1}-$ster^{-1}$-BeV^{-1}, where E is given in BeV. Comparison of these findings with the findings of other investigators reveals some differences which, in the >3-BeV region, may be attributed to methodological factors. Analysis of the electron recording effectiveness as a function of the magnitude of the established thresholds in the discriminating element of the scintillator makes it possible to obtain information on fluctuations in the number of electrons in electron–photon avalanches. (JPRS)

21964 COMPOSITION OF THE PRIMARY COMPONENT OF COSMIC RADIATION. Bogomolov, E. A.; Karakad'ko, V. K.; Lubyanaya, N. D.; Romanov, V. A.; Totubalina, M. G.; Yamshchikov, M. A. (Ioffe Inst. of Physics and Tech., Leningrad). Izv. Akad. Nauk SSSR, Ser. Fiz., 31: 1237-8(Aug. 1967). (In Russian).

The investigation of azimuthal asymmetry is the principal method of determining the charge polarity of particles of primary cosmic radiation. In this connection, telescopes consisting of scintillation counters, and gas and water Cherenkov counters were constructed in order to measure azimuthal asymmetry of protons in the middle latitudes (telescope angle with respect to the vertical: 45°). The integral spectra of singly charged particles were plotted in the east and west directions showed that below the geomagnetic threshold for protons the telescope records a large number of particles. The asymmetry of these particles is roughly similar to the asymmetry of the particles above the geomagnetic threshold. Clearly, they chiefly are secondary particles generated in the residual atmosphere, but part of them may be deuterons. The obtained spectrum indicates that in the 2 to 3 BeV-nucleon^{-1} range the deuteron flux accounts for not more than 10% of the total proton flux. (JPRS)

21965 ENERGY SPECTRUM OF PRIMARY COSMIC RAYS IN THE REGION OF EXTREMELY LOW ENERGIES BEYOND THE CONFINES OF THE SOLAR SYSTEM. Dorman, I. V.; Dorman, L. I. (Inst. of Terrestrial Magnetism, Ionosphere, and Radio Wave Propagation, Moscow). Izv. Akad. Nauk SSSR, Ser. Fiz., 31: 1239-46(Aug. 1967). (In Russian).

The spectrum and nuclear composition of cosmic rays measured in the low-energy range during solar activity minima cannot be the same as in galactic space beyond the confines of the solar system, since even during the solar activity minimum there exists a solar wind having the radial velocity of ~300 km-sec^{-1}; this wind must cause a marked modulation of galactic cosmic rays, a modulation that is greater the smaller the particle energy is. If the depth of this modulation could be determined, the problem of determining the spectrum and nuclear composition of cosmic rays beyond the confines of the solar system could be solved. It is shown that the most rational way of solving this question is the utilization of the known data on cosmic rays to derive the parameters of the modulation. On the basis of the data on simultaneous measurements of proton and α-particle spectra during periods of variation in solar activity it is shown that when an allowance is made for modulation the energy density of cosmic rays in galactic space turns out to be several times as high as normally assumed. (JPRS)

21966 COSMIC-RAY RESEARCH WITH THE AID OF THE KOSMOS-53 ARTIFICIAL SATELLITE. Vernov, S. N.; Gorchakov, E. V.; Ignat'ev, P. P.; Nikolaev, A. G. (Moscow State Univ.). Izv. Akad. Nauk SSSR, Ser. Fiz., 31: 1250-1(Aug. 1967). (In Russian).

Data provided by the Kosmos-53 satellite during the geomagnetically quiet time from Jan 30 to Feb 4, 1965, were analyzed. During the flight of this satellite outside the radiation belts its apparatus recorded cosmic rays and the associated emission due to the interaction between primary cosmic rays and the atmosphere and the material of the satellite. The dependence of secondary emission on the energy of primary particles is plotted; when this energy is >2 BeV, the dependence roughly follows the $E^{-0.5}$ law. The increase in the mean number of cascade protons per inelastic interaction of primary protons follows the ~$E^{0.5}$ law; apparently, the presence of additional emission may be attributed to the multiplication of primary particles in the material of the satellite or to the presence of reentrant albedo particles. The latter assumption seems more valid, since cosmic-ray intensity in the region of the equator is weakly dependent on the weight of the artificial satellite, as indicated by a comparison of the readings of the gas-discharge counters of the satellites Kosmos-53 and Explorer VII which markedly differ in weight. Curves of secular variations in the spectrum of primary cosmic rays over the period 1960–1965 indicate that in 1965 this spectrum was particularly rich in soft particles. (JPRS)

21967 VARIATIONS OF COSMIC RAYS IN VARIOUS REGIONS OF INTERPLANETARY SPACE ACCORDING TO THE DATA OF THE ZOND-3 AND VENERA-2 SPACE PROBES. Vernov, S. N.; Chudakov, A. E.; Vakulov, P. V.; Logachev, K. I.; Lyubimov, G. P.; Pereslegina, N. V. (Moscow State Univ.). Izv. Akad. Nauk SSSR, Ser. Fiz., 31: 1259-61(Aug. 1967). (In Russian).

The intensity of cosmic rays was measured in two space probes, Venera-2 and Zond-3, one approaching the Sun and the other receding from the Sun; in this way time variations in this intensity could be taken into account and the dependence of the intensity on the distance to the Sun (i.e., the radial gradient) could be determined, during the 1965–1966 period. Findings: variations in cosmic-ray intensity in interplanetary space differ in different regions of that space and are not simultaneous. Hence the radial gradient was determined by selecting two curve segments pertaining to the initial and terminal stages of the flight of Venera-2 and Zond-3; the value of the radial gradiant thus derived $\delta = (3.1 \pm 0.4)\%$ per astronomical unit. The nonuniformity of variations in cosmic-ray intensity in various regions of the solar system may

be conditioned by the travel of magnetic inhomogeneities. The p detectors (sensitive to protons with energies of 1 to 5 MeV) installed in the artificial satellites revealed an extremely stable and fairly steady background that is about 10 times as high as the possible background due to high-energy particles. When the distance to the Sun increased to 190×10^6 from 130×10^6 km, the intensity readings given by these detectors increased by a factor of 5; this is difficult to explain, nevertheless certain mechanisms qualitatively explaining an increase in intensity with increase in distance from the source may be proposed if it is considered that one is dealing with intensity outside the channels via which the ejection of particles from the Sun proceeds. (JPRS)

21968 VARIATION OF THE ENERGY SPECTRUM OF GALACTIC COSMIC RAYS DURING 11-YEAR SOLAR ACTIVITY CYCLE. Stozhkov, Yu. I.; Charakhch'yan, T. N. (Lebedev Inst. of Physics, Moscow. Moscow State Univ.). Izv. Akad. Nauk SSSR, Ser. Fiz., 31: 1262-4(Aug. 1967). (In Russian).

Measurements of cosmic-ray intensity in the stratosphere at the depths of x = 10 to 300 $g \cdot cm^{-2}$ in the region of Murmansk and, beginning with 1963, in the Antarctica (Mirnyi Station) were analyzed over the period from 1959 to 1965. It was established that during 1959 to 1963 the energy spectra of the secular variations in the intensity of cosmic rays remained virtually unchanged, whereas during the period of solar activity minimum (1964–1965) they changed sharply in the direction of an increase in the soft component. This was paralleled by a concomitant increase in the diffusion coefficient of cosmic rays in interplanetary space. (JPRS)

21969 MODULATION EFFECTS OF THE NUCLEAR COMPONENT OF COSMIC RAYS DURING THE SOLAR ACTIVITY MINIMUM. Kurnosova, L. V.; Razorenov, L. A.; Suslov, A. A.; Fradkin, M. I. (Lebedev Inst. of Physics, Moscow). Izv. Akad. Nauk SSSR, Ser. Fiz., 31: 1265-8(Aug. 1967). (In Russian).

Quasi-periodic variations in the intensity of the nuclear component of cosmic rays, associated with the transit of active regions across the solar disk (27-day variations) were investigated by the spoch superposition method; the same method was also used to analyze the relationship between these variations and the K index of geomagnetic activity. The data analyzed were provided by the Elektron-2 and Elektron-4 cosmic-ray recording satellites as well as by ground-based stations for the observation of magnetic storms. Findings: the variations in the fluxes of various groups of nuclei and protons satisfactorily correlate with the manifestations of geomagnetic activity. The depth of modulation in the recorded effects of decrease in the intensity of the nuclear component was roughly the same for groups of nuclei having the charges $Z \geq 2$, $Z \geq 5$, and $Z > 15$ to 20, which points to the absence of any marked charge dependence of the depth of modulation so far as Forbush decreases are concerned. Analysis of the modulation effects of the nuclear component of cosmic rays showed that during the solar activity minimum the modulation of the intensity of cosmic rays instead of decreasing produces a marked effect even on particles of sufficiently high energies ($E_{kin} \gtrsim 600$ MeV-nucleon^{-1}). (JPRS)

21970 NATURE OF 11-YEAR COSMIC-RAY VARIATIONS AND THE PROPERTIES OF SOLAR WIND. Dorman, I. V.; Dorman, L. I. (Inst. of Terrestrial Magnetism, Ionosphere, and Radio Wave Propagation, Moscow). Izv. Akad. Nauk SSSR, Ser. Fiz., 31: 1273-8(Aug. 1967). (In Russian).

Two models of particle diffusion in interplanetary space are considered. The first model presupposes scattering in the principal modulation region by isolated magnetic clouds whose dimensions in the interplanetary medium cannot increase faster than at the speed of sound. The second model presupposes that modulation beyond the confines of the Earth's orbit is chiefly determined by a quasi-regular radially expanding interplanetary field whose lines of forces are shaped like the spiral of Archimedes, in the presence of sectorial structure. At a distance of R_E the magnetic field is chiefly azimuthal and the Archimedean spiral executes a complete revolution through the range of ~6 A.U. at a velocity of 300 km-sec^{-1}. It is established that recovery of cosmic-ray intensity following a solar activity maximum occurs with a considerable delay which is the greater the smaller the particle hardness. The principal cause of this phenomenon is tentatively attributed to the formation of a relatively immobile spherical "buffer layer" with a relatively short transport path for particle scattering; this layer must occur in the neighborhood of the boundary between the solar wind and the galactic magnetic field and galactic low-energy cosmic particles. (JPRS)

21971 11-YEAR VARIATIONS OF COSMIC RAYS AND SOLAR ACTIVITY. Salimzibarov, R. B. (Inst. of Cosmophysics Research and Aeronomy, Irkutsk, USSR). Izv. Akad. Nauk SSSR, Ser. Fiz., 31: 1279-80(Aug. 1967). (In Russian).

The time lag T of the extremum of cosmic-ray intensity with respect to the corresponding extremum of the sunspot cycle for various primary-particle energies E was analyzed from the standpoint of a model explaining the "hysteresis" between cosmic-ray intensity and the area of the sunspots. It was established that during the maxima and minima of solar activity the relation of time lag T to primary-particle energy E is written as $T(E) \sim E^{-0.5 \pm 0.9}$. This time lag averages 7.5 months during the solar activity minimum, which corresponds to an effective primary particle energy of 51 BeV, and is generally shorter during the solar activity maximum, which contradicts the conclusions of the theory that the dimensions of the modulation region are determined by the equilibrium between the kinetic energy of solar wind and the pressure of the interplanetary medium; this indicates that the formation of the modulation region is not determined by the above mechanism. (JPRS)

21972 GENERATION OF FAST PARTICLES IN OUTER SPACE. Syrovatskii, S. I. (Lebedev Inst. of Physics, Moscow). Izv. Akad. Nauk SSSR, Ser. Fiz., 31: 1303-6(Aug. 1967). (In Russian).

Present-day theories of cosmic-ray acceleration mechanisms are considered from the standpoint of the following general requirements for these mechanisms: (a) the acceleration occurs in cosmic plasma and is of an electromagnetic nature, i.e., in the final analysis conditioned by electrical fields occurring in such a system; (b) the process of acceleration is nonadiabatic in that the particles retain their acquired energy following the return of system to original state; (c) the energy source is macroscopic motions of cosmic plasma; the acceleration mechanism with high efficiency converts this energy to the energy of fast particles. The acceleration mechanisms may be classified in accordance with the nature of electrical fields implied by condition (a). Condition (b) is satisified for the particles having the velocity $v > v_{ph}$, where v_{ph} is the phase velocity of plasma waves; the corresponding plasma mechanism of acceleration is statistical and is equivalent to diffusion in the space of energies. Microfields conditioned by high-frequency plasma oscillations do not require the presence of a magnetic field, but the electrical macroscopic induction fields occur only in the presence of a magnetic field. In the cumulative electrical fields (cumulative mechanism of acceleration) all particles regardless of their initial energy and mass get accelerated in the cumulation region, i.e., injectionlessly. Then the electrons and various ions acquire identical momenta per charge unit; this mechanism is of a clearly nonadiabatic nature and converts a large part of the kinetic energy of the plasma (which is the cause of magnetic cumulation) to the energy of the accelerated particles. Such a mechanism is apparently responsible for the cosmic rays of solar flares and may play an important role in the turbulent plasma of the envelopes of the supernovae, galactic nuclei, and radio galaxies. (JPRS)

21973 ANISOTROPY OF COSMIC RAYS AND ITS VARIATION DURING THE CYCLE OF SOLAR ACTIVITY. Kolomeets, E. V. (Kazakh State Univ., Alma-Ata, USSR). Izv. Akad. Nauk SSSR, Ser. Fiz., 31: 1324-32(Aug. 1967). (In Russian).

The variation in the anisotropy of cosmic rays with a 27-day period indicates that variations of this kind exist during the cycle of solar activity but are absent in the neighborhood of the maxima and minima of solar activity. Studies of the course of the amplitude and energy spectrum of solar-diurnal variations during the 1957–1965 period indicate that source power during the solar activity minimum is 1.2 times as low as during the maximum. Energy spectrum of anisotropy is of an exponential kind, with the exponent ranging from 0 to −0.5; as the solar activity decreases, the energy spectrum of diurnal variation becomes softer. Analysis of the course of the phase of diurnal variation during 1933 to 1956 indicates that this phase varies with a period of 22 years and its extremal points lie at the minima of solar activity. Thus between 1933 and 1943 the maximum time set in later and between 1947 and 1954, earlier. Further, no explicit relationship could be established between the course of the amplitude and phase of the semidiurnal variation and the course of solar activity, and the nature of this variation still remains unclear; it has been shown, however, that its amplitude increases with increase in energy; its energy spectrum is of the exponential kind with a positive exponent ranging from +0.2 to +0.9. (JPRS)

21974 NATURE OF THE ANISOTROPY OF COSMIC RAYS IN THE SOLAR SYSTEM. Dorman, L. I. (Inst. of Terrestrial Magnetism, Ionosphere, and Radio Wave Propagation, Moscow). Izv. Akad. Nauk SSSR, Ser. Fiz., 31: 1333-9(Aug. 1967). (In Russian).

Studies of the anisotropy of cosmic rays and its variations should provide more information than studies of variations in integral intensity, but a present greater emphasis is placed on

the latter studies owing to the difficulties involved in evaluating real anisotropy in interplanetary space according to the anisotropy observable from Earth. Now, however, it is becoming increasingly feasible to overcome these difficulties by making proper allowance for the geometry of the Solar system, the effect of the geomagnetic field, and the special features of recording apparatus. Another difficulty—the determination of the relative role of the various proposed mechanisms of diurnal variation in cosmic rays—also is now being surmounted by working out the general picture of the anisotropy of cosmic rays in interplanetary space under the action of regular magnetic fields of the solar wind spreading from the Sun. Formulas for the diurnal variation and mean radial gradient of intensity of cosmic rays are presented and estimates of mean diurnal variation in the neighborhood of the Earth's orbit are provided. The pattern of variation in anisotropy with approach to and increasing distance from the Sun is analyzed. It is shown that a detailed analysis of diurnal variations free of the effect of the Earth's atmosphere and magnetic field can, in accordance with the formulas presented, provide valuable information on the gradients of cosmic rays, the asymmetry of solar wind, the transport path for scattering, and the variability of conditions in interplanetary space. (JPRS)

21975 DIURNAL ANISOTROPY DURING THE SOLAR ACTIVITY MINIMUM. Kolomeets, E. V.; Sergeeva, G. A.; Chumbalova, R. A. (Kazakh State Univ., Alma-Ata, USSR). Izv. Akad. Nauk SSSR, Ser. Fiz., 31: 1340-2(Aug. 1967). (In Russian).

Solar diurnal variations from day to day during the 1964–65 solar activity minimum were investigated on the basis of data from six supermonitors: Churchill, Deep River, Sulphur, Climax, Dallas, and Calgary. The data were subjected to harmonic analysis with determination of amplitudes and phases of diurnal variation. It turned out that the first-harmonic amplitude undergoes great fluctuations from day to day. An investigation of the frequency distribution of the amplitudes and phases of the diurnal variations during the solar activity minimum showed that the most probable amplitude of diurnal variation at all the stations was within the range of 0.25 to 0.30%. The frequency distribution of phases point to a latitudinal dependence: as the latitude increases, the maximum time shifts to later hours. The maximum area of sunspots was observed 4 to 5 days prior to the onset of maximum amplitudes of diurnal variation; hence the velocity of the flux responsible for these variations is 315 to 350 km-sec^{-1}. The time of the maximum of diurnal variation was found to sharply deviate in the direction of late or early hours during magnetically disturbed periods (magnetic storms). It may be assumed that during those periods the sectorial structure of the interplanetary magnetic field with various directions of the field possibly manifests itself. (JPRS)

21976 FRAGMENTATION PARAMETERS OF MULTI-CHARGED COMPONENT OF PRIMARY COSMIC RAYS. Gagarin, Yu. F.; Ivanova, N. S. Kosm. Issled., 5: 450-5(May-June 1967). (In Russian).

Nuclear emulsions were exposed at heights at 300 km and the interactions of heavy cosmic nuclei with a number of black and grey rays ≤1, in relation to the nuclei targets, were separated out. The fragmentation parameters of the heavy nuclei in "hydrogen" emulsions were obtained. The interactions of protons at 10 BeV with nickel nuclei, introduced in the emulsion in the form of spherical particles with diameter 9 μm, were investigated and the probabilities were obtained for the transition of nickel nuclei into the groups H (Z ≥ 10), H_1 (Z = 20 to 28), H_2 (Z = 16 to 19), H_3 (Z = 10 to 15), M (Z = 6 to 9), and L (Z = 3 to 5). (tr-auth)

21977 ON TRAPPING OF GALACTIC COSMIC RAYS. van Loon, L. G. (Univ. of California, Berkeley). Nuovo Cim., 54B: 145-6(Mar. 11, 1968).

It is important to know whether galactic cosmic rays are trapped permanently in the magnetic fields of the Galaxy or whether they escape rapidly away into metagalactic space. Though a lower limit of 10^3 years for T_{TR} (characteristic escape time) has been established from considerations of anisotropies in the Galaxy, an upper limit has never been found. The present indication is that dN/dE_N is close to zero between 1 and 100 GeV/N which implies an upper limit to the cosmic-ray age in the Galaxy. (W.D.M.)

21978 LOW-ENERGY HEAVY PRIMARY PARTICLES IN COSMIC RADIATION. Malmqvist, L. (Univ. of Lund, Sweden). Ark. Fys., 34: 33-8(1967).

Charge and energy spectra of the low-energy heavy primary particles in cosmic radiation were studied in a nuclear emulsion stack that was exposed at 2.7 g/cm^2 of residual atmosphere, at Fort Churchill, on July 28, 1963. Photometric identification measurements were made on 114 tracks of stopping heavy primary particles. In the energy range 150 to 250 MeV per nucleon the L/M ratio was found to be 0.38 ± 0.13. The differential flux values observed are given. These values are in agreement with those found in other investigations made in the summer of 1963. (auth) (Sweden)

21979 EFFECTS OF THE DECAY OF NUCLEON ISOBARS AND HYPERONS ON THE COSMIC GAMMA-RAY SPECTRUM. Stecker, F. W.; Tsuruta, S.; Fazio, G. G. (Smithsonian Astrophysical Observatory, Cambridge, Mass. Harvard Coll. Observatory, Cambridge, Mass.). Astrophys. J., 151: 881-93 (Mar. 1968).

In interstellar and intergalactic cosmic-ray proton–proton collisions it is possible to produce nucleon isobars and hyperons that carry off a large fraction of the energy available in the collision. The delayed gamma rays that result from the decay of these particles also carry a large fraction of the available gamma-ray energy. The galactic gamma-ray spectrum due to the decay of the nucleon isobars $N_3^*(1.410)$ and $N_3^*(1.688)$, for which the excitation involved no change of isotopic spin or strangeness, and due to the decay of hyperons (Λ, Σ^+, Σ^0), was calculated. Results show that these reactions may be an important source of gamma rays of energy greater than 6 TeV (6×10^{12} eV). (auth)

21980 COSMIC GAMMA RAYS FROM INVERSE COMPTON SCATTERING. Shen, C. S.; Berkey, G. (Purdue Univ., Lafayette, Ind.). Astrophys. J., 151: 895-900(Mar. 1968).

In this paper the background gamma radiation due to inverse Compton scattering of the 3°K black-body photons by galactic cosmic-ray electrons is calculated. The distribution of galactic cosmic-ray electrons is derived from the general diffusion equation by including the effect of spatial diffusion in addition to that due to energy loss and leakage. An estimation of the metagalactic contribution to the background radiation is also made, and it is shown that due to an expected steepening in the radiation spectrum around a few MeV, the metagalactic flux lies below the galactic component in the gamma-ray range. The intensity and anisotropy of the background gamma radiation which depends on the spatial distribution of the sources of the cosmic-ray electrons, are calculated from various models of origin of cosmic rays. The results are compared with the present observational upper limit on cosmic gamma rays. (auth)

21981 POLARIZATION OF AN AMPLIFYING MEDIUM AND OF COSMIC OH RADIATION. Heer, C. V.; Bupp, J. R. (Ohio State Univ., Columbus). Phys. Lett., 26A: 354-5(Mar. 11, 1968).

A theory of the polarization of amplified radiation for the full Doppler width is considered. A method for coupling the polarization of the oppositely directed traveling waves of an amplifying cloud through emission of polarized spontaneous radiation by atoms aligned or polarized by saturating radiation is suggested. (auth)

Direct Energy Conversion

Refer also to abstract 22792.

21982 (CEA-R-3418) GENERATEUR THERMOIONIQUE ISOTOPIQUE. (Isotopic Thermionic Generator). Clemot, Max; Devin, Bernard; Durand, Jean-Paul (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires). Dec. 1967. 26p. (In French). Dep.

The general design of a thermionic direct conversion space generator is described. The power source used is a radioisotope. Two radioisotopes are considered: ^{238}Pu and ^{244}Cm. The system is made up of a heat pipe concentrating the thermal flux from the isotope to the emitter, and of a second heat pipe evacuating the waste heat from the collector to the outer wall used as radiating panel. Calculations are given in the particular case of a 100 electrical watts output power. (auth)

21983 (CONF-661204–(Vol.2), pp 69.1-12) INVESTIGATION OF DIRECT ENERGY CONVERSION UTILIZING A SUPERCONDUCTING FLUX BARRIER. Irey, R. K.; Goodling, J. S. (Florida Univ., Gainesville); Schwebel, C. D. (Boeing Co., Cocoa Beach, Fla.).

A novel method for direct conversion of solar energy to electrical energy is described which, if it subsequently proves feasible from the standpoint of power–weight ratio, could have great potential as a means of primary space power generation. Three different energy conversion cycles, which utilize the change of magnetic properties associated with the phase change in a superconductor have been analyzed. A device was built and operated to investigate the workability of such a converter and to determine

the presence of heat effects in the cycle. An electromagnet and pickup coil were separated by a thin sheet of superconductive lead which was heated to above the transition temperature while in the presence of a magnetic field, thus allowing flux to pass through the pickup coil and inducing a voltage. Reproducible voltages were observed across the pickup coil upon the application of heat (only) to the superconductor and output energies ranged from 85.6×10^{-6} to 1.8×10^{-6} joule depending on load resistance. Efficiency based on energy input during output and total output as a result of input was 0.625×10^{-2} to 0.005×10^{-2}% depending on load resistance. Due to uncertainty of experimental data and instrumentation, no conclusions have been made as to the presence of heat effects upon the cycle. (auth)

21984 (LA-DC-6135) VISCOSITY OF CESIUM VAPORS. Weaver, C. V.; Todd, J. (Los Alamos Scientific Lab., N. Mex.). [nd]. Contract W-7405-eng-36. 4p. (CONF-671045-6). Dep. CFSTI.

A continued study of the viscosity of cesium vapors by a transpirational method over a temperature range from 1000° to 2400°K has demonstrated the effect of partial ionization on the coefficient of viscosity. A correlation of the experimental results with a theoretical study has been made. (auth)

21985 PERFORMANCE OF A LARGE MHD-TYPE STABLE SUPERCONDUCTING MAGNET. Stekly, Z. J. J. (Avco-Everett Research Lab., Everett, Mass.). pp 237-46 of Les Champs Magnetiques Intenses, leur Production et leurs Applications. Paris, Centre National de la Recherche Scientifique, 1967.

From International Colloquium on Intense Magnetic Fields, their Production and their Applications, Grenoble, France. See CONF-660921.

After a short introduction to the principle of a magnetohydrodynamic generator (MHD), an experimental generator, located at Avco-Everett, with an excitation coil made with copper is described. The amount of dissipated energy for the excitation of the inductive coil and the interest of producing this field with a superconducting solenoid are discussed. A solenoid made with Nb-Zr wire, 3.05-m length, 30.5-cm inside diameter providing a 37-kOe field perpendicular to its axis is described. The Dewar is equally described; results of various experiments are indicated. (auth)

Fluid Physics

21986 SOME PROBLEMS OF THE THEORY OF PLANE JETS OF A CONDUCTIVE FLUID. Dzhaugashtin, K. E. Zh. Prikl. Mekh. Tekh. Fiz., No. 4, 21-9(July-Aug. 1967). (In Russian).

Problems of the propagation of plane jets of a conductive fluid in a transverse magnetic field are investigated in a noninductive approximation on the basis of boundary layer equations. Dynamic and thermal problems of laminar free and semilimited jets propagating in a magnetic field of arbitrary distribution are investigated within the framework of an asymptotic boundary layer. A system of ordinary differential equations and an integral condition are derived from the initial partial differential equations. The solution of these equations is demonstrated on an example of jet propagation in a uniform magnetic field. An analogous solution is obtained for a free turbulent jet whose turbulent exchange coefficient is determined on the basis of the Prandtl scheme. (ATD)

21987 DISTORTION OF THE MAGNETIC FIELD DURING THE FLOW OF AN ELECTRICALLY CONDUCTING FLUID AROUND A CIRCULAR OBSTACLE. Marcov, N. (Univ., Bucharest). Stud. Cercet. Mat., 19: 1039-46(1967). (In Rumanian).

R. Seebass and K. Tamada obtained a solution for the problem presented by the plane flow of a perfect, electrically conducting fluid past a symmetric obstacle for the case of a circular obstacle. The problem was extended by examining the flow of such an incompressible fluid around a circular cylinder, however, without assuming that the intensity of the magnetic field at infinity is parallel with the direction of the flow velocity. It was assumed that the perfect fluid possesses a certain electric conductivity σ and the cylinder is made of a material with a finite conductivity σ_0; the fluid and this material were considered as being electrically homogeneous and isotropic and possessing the same magnetic permeability. On the basis of a small parameter of interaction, it was found that the flow of the conducting fluid corresponds to the potential flow of a nonconducting fluid. Using the complex potential plane for the flow of the fluid, the induced magnetic field may be determined by resolving two integral equations which yield an expression for the force function in the complex potential plane. (TTT)

21988 PLANE-PARALLEL FLOW OF VISCOUS INCOMPRESSIBLE LIQUIDS IN CHANNELS UNDER THE EFFECTS OF A TRANSVERSE MAGNETIC FIELD. Kalis, Kh. E.; Tsinober, A. B. Izv. Sib. Otd. Akad. Nauk SSSR, No. 8, Ser. Tekh. Nauk, No. 2, 16-22(June 1967). (In Russian).

The stationary flow of viscous conductive liquids in channels of complex form in the presence of a constant magnetic field is examined. An appropriate system of equations, analogous to the Navier-Stokes equation, is solved numerically by the method of resolution. The velocity distribution is obtained, and the results were compared with the analytical solutions in the simplest cases. (tr-auth)

21989 SOME COINCIDENCES IN MAGNETOFLUIDDYNAMICS. Upadhyaya, K. S. (Univ. of Allahabad, India). Ann. Soc. Sci. Brux. Ser. 1, 81: 292-7(Dec. 31, 1967).

Expressions for the vorticity and the current density generated behind the shock were obtained under two conditions, namely, when the current vector coincides with the magnetic line and when the vorticity vector coincides with the stream-line. In this process it is shown that vorticity and current-density generated by the shock under the above mentioned conditions are derivable purely from the dynamical considerations. (auth)

21990 DISSIPATIVE INSTABILITY OF THE NONISOTHERMAL ELECTROCONDUCTING FLOW BETWEEN PARALLEL PLANES IN A TRANSVERSE MAGNETIC FIELD. Sanochkin, Yu. V. Zh. Prikl. Mekh. Tekh. Fiz., No. 5, 21-8(Sept.-Oct. 1967). (In Russian).

The development of short-wave perturbations was studied, considering viscosity and heat transfer. Also, in order to expand the scope of the $A \ll 1$ conditions, studies included the instabilities of superheating for the whole range of wave lengths in the nonisothermal plasma flow in MHD channels. (R.V.J.)

21991 NEAR-ELECTRODE LAYERS IN HIGHLY CONDUCTING NONVISCOUS PLASMA FLOW. Morozov, A. I.; Shubin, A. P. Zh. Prikl. Mekh. Tekh. Fiz., No. 5, 14-20(Sept.-Oct. 1967). (In Russian).

The structure of electromagnetic near-electrode layers formed in a magnetic field by a transverse flow of a completely ionized, strongly conducting nonviscous plasma with a large magnetic Reynolds' number was studied using linear approximations. Specific cases of the streamlined flow over undulated walls and in a plane channel with slowly changing cross section and segmented electrodes were examined. The formulation of dissipative near electrode layers with Debye or electron Larmor radii was calculated according to the rate of diffusion into magnetic fields. (R.V.J.)

21992 ANISOTROPIC CONDUCTING FLUID FLOW IN A CHANNEL AT THE MAGNETIC FIELD INLET ZONE. Vatazhin, A. B.; Kholshchevnikova, E. K. Zh. Prikl. Mekh. Tekh. Fiz., No. 5, 9-13(Sept.-Oct. 1967). (In Russian).

Formulas for anisotropic conducting fluid flow in a channel with ideally sectioned electrodes were obtained by means of the Furie method. The series obtained in which the slowly converging part was combined with the asymptotic profile (calculated by ordinary equations), was used for finding the field of velocities. A detailed diagram was constructed for the velocity profile deformation. The general properties of flow at the magnetic field inlet zone were analyzed in order to determine the order of error in the calculations. (R.V.J.)

21993 ACCELERATION OF CONDUCTING FLUID IN MAGNETOHYDRODYNAMIC CHANNEL WITH ACCOUNT OF NATURAL AND RECIPROCAL INDUCTION IN THE EXTERNAL CIRCUIT. Ryabinin, A. G.; Khozhainov, A. I. Zh. Prikl. Mekh. Tekh. Fiz., No. 5, 104-6(Sept.-Oct. 1967). (In Russian).

Acceleration of a viscous incompressible conducting fluid in an MHD channel with electrodes wired to a closed circuit was analyzed; this circuit contained active resistance and inductance connected with the reciprocal inductance of a second circuit. The problem was resolved considering unsteady laminar flow in a long rectangular-cross-section channel in the presence of a homogeneous magnetic field. Data indicate that the presence of reactance in the circuit induces periodical acceleration of the conducting fluid, with the reciprocal inductance reducing the oscillation amplitudes. (R.V.J.)

21994 METHOD FOR DETERMINING LINEAR SOLUTIONS IN MAGNETOHYDRODYNAMICS. Savage, M. D. (Leeds Univ., Eng.). J. Inst. Math. Appl., 4: 20-32(Mar. 1968).

Given any two-dimensional and incompressible flow described by a set of linear partial differential equations, a method is presented for determining the solution for the dependent variables (velocity, pressure, etc.). The method is then used to investigate the following magnetohydrodynamic flows: (a) the flow of an irrotational and

inviscid fluid, (b) the flow of a viscous fluid, (c) the flow of an electrically conducting, inviscid fluid in the presence of a magnetic field aligned with the flow at infinity, and (d) the flow of an electrically conducting, viscous fluid in the presence of a magnetic field having arbitrary direction. (auth)

21995 HYDROMAGNETIC FLOW OVER A PERFECTLY CONDUCTING PLANE WALL WITH UNIFORM SUCTION. Ray, M.; Agrawal, J. C. (Agra Coll., India). Bull. Calcutta Math. Soc., 56: 171-5(1964).

An exact solution for the problem of steady flow of an electrically conducting, incompressible, viscous fluid of constant electric and magnetic properties over a perfectly conducting plane wall with uniform suction in the presence of a transverse magnetic field has been worked out. (Indian Sci. Abstr.)

21996 STEADY HYDROMAGNETIC FLOW IN A CHANNEL WITH POROUS AND CONDUCTING WALLS IN THE PRESENCE OF A TRANSVERSE MAGNETIC FIELD. Ray, M.; Agrawal, J. C. (Agra Coll., India). Bull. Calcutta Math. Soc., 56: 163-70 (1964).

An exact solution of a modified Navier–Stokes equation governing the steady flow of a conducting fluid between two parallel conducting porous infinite plane walls is given. When the suction or injection at the walls is made to vanish the flow reduces to the one described by Chang and Yen (Z. Angew Math. Phys., 13: 266(1962)). (Indian Sci. Abstr.)

21997 LAMINAR FLOW OF A CONDUCTING LIQUID IN AN OPEN CHANNEL. Kolovandin, B. A. (Donetsk Scientific Research Inst. for Ferrous Metallurgy, USSR). Izv. Vyssh. Ucheb. Zaved., Energ., No. 7, 70-6(1966). (In Russian).

The article considers a flow bounded by nonconducting walls and a free surface. Perpendicular to the side walls of the channel, inclined to the horizontal at a certain angle β, there is placed a magnetic field B_0. It is assumed that the velocity of the liquid has a single component. The problem is first solved mathematically for arbitrary values of the Hartmann number, and then for large values of the Hartmann number. The final equations arrived at are valid only in the core of the flow, since near the walls, the role of terms of higher order in the equations increases. (ATD)

21998 HYDROMAGNETIC FORCED FLOW OF REINER–RIVLIN FLUID AGAINST A ROTATING DISK. Balaram, M. J. Phys. Soc. Jap., 21: 1421-31(1966).

Hydromagnetic and cross-viscous effects on the forced flow of a non-Newtonian liquid against a rotating disk are presented. The problem has been solved by using Karman–Pohlhausen method. It is found that the cross-viscous and magnetic effects depend on two non-dimensional members R_c and m respectively. Numerical solutions have been obtained for the radial shear stress, torque acting on the disk, and boundary layer thickness. The effect of cross viscosity is to decrease the magnitudes of the radial and tangential components of the velocity. The radial velocity component of the fluid increases while the tangential component decreases as the strength of the magnetic field increases. (Indian Sci. Abstr.)

21999 FLUCTUATING FLOW NEAR A STAGNATION POINT UNDER AN AXIAL MAGNETIC FIELD. Dutta, N. J. Sci. Eng. Res., Indian Inst. Technol., Kharagpur, 9: 201-6(1965).

The effect of an axial magnetic field on the fluctuating flow near a stagnation point has been studied when the main stream fluctuates in magnitude only. The velocity profile is obtained for the two limiting cases of low and high frequency. The velocity profile from both approximate solutions are in good agreement for a critical frequency which increases with the increase of the magnetic field. (Indian Sci. Abstr.)

22000 STABILITY OF GRAVITATING CYLINDER IN THE PRESENCE OF MAGNETIC FIELDS. Gandhi, J. M.; Vinayak, B. P. (Rajasthan Univ., Jaipur, India). Proc. Nat. Acad. Sci. India, Sect. A, 34: 495-500(1964).

The stability of an infinitely long gravitating cylinder of incompressible, inviscid, and infinitely conducting fluid in the presence of a magnetic field having both poloidal (of the form $H_z = A\,[(R_0^2 - \gamma^2)^{1/2}]$ and toroidal (of the form $H = A\gamma$) components was investigated. It is shown that the field has a stabilizing effect on the cylinder. The value of the rms magnetic field inside the cylinder is compared with that obtained by earlier workers. (Indian Sci. Abstr.)

22001 TURBULENT FLOW OF AN ELECTRICALLY CONDUCTING FLUID WITH A FREE SURFACE IN THE PRESENCE OF OVERLAPPING MAGNETIC AND ELECTRIC FIELDS. Kolovandin, B. A. Gidroaeromekhanika, No. 4, 3-9(1966). (In Russian).

The mathematical treatment is based on a semi-empirical theory. It is assumed that in the turbulent core, viscous diffusion and convective pulsation may be neglected; thus, the equation for the pulsation energy reduces to the equation for the balance between the generation and the dissipation of turbulent energy. It is demonstrated mathematically, on the above assumptions, that the imposition of magnetic and electric fields deforms the profile of the mean velocity; this leads to the possibility of obtaining a resistance coefficient which differs to a greater or lesser degree from the coefficient determined in the classical hydrodynamic problem. Results of calculations taking into account only a single magnetic field agree with previous results for flow in a tube. (ATD)

22002 BOUNDARY VALUE PROBLEM FROM THE THEORY OF MAGNETOHYDRODYNAMIC FLOW. Johnson, W. E. (Lockheed Missiles and Space Co., Palo Alto, Calif.). Arch. Ration. Mech. Anal., 22: 355-63(1966).

Mathematical investigation of the question of the existence and uniqueness of solutions of Greenspan and Carrier's pair of ordinary differential equations and resulting boundary value problem that describes the steady two-dimensional flow of a viscous incompressible electrically conducting fluid past a semi-infinite rigid plate. Investigation is made for the case $\epsilon = 1$. It is shown that for each β in the interval $0 < \beta < 1$ the problem has a unique solution, whereas, if $\beta \geq 1$, it has no solution; moreover, as $\beta \to 1$, the functions $f(\eta)$, $f'(\eta)$, $g(\eta)$, and $g'(\eta)$ approach zero uniformly in η on any finite interval. It is also shown that as $\beta \to 0$, $f(\eta)$ approaches the solution of the Blasius problem uniformly in η on any finite interval. (IAA)

22003 INFLUENCE OF AXIAL CONDUCTION ON THE THERMAL ENTRY-REGION HEAT TRANSFER IN MAGNETOHYDRODYNAMIC CHANNEL FLOW. Hsu, Chia-jung; Lindauer, George C. (Brookhaven National Lab., Upton, N. Y.). Nucl. Sci. Eng., 32: 16-29(Apr. 1968).

The influence of axial conduction on thermal entry-region temperature distribution and heat transfer in Hartmann flow through a magnetohydrodynamic channel was analytically investigated. Viscous dissipation and Joule heating were also considered in the analysis. The temperature solutions, which are found to be Peclet number dependent, reduce to those corresponding to negligible axial conduction as the Peclet number approaches infinity. The appropriate first 12 eigenvalues and the corresponding eigenfunctions were determined for Hartmann numbers of 1, 4, and 10 and for a wide range of Peclét numbers. The series expansion coefficients, applicable to an arbitrary value of the heat-generation parameter, were evaluated for a few electric-field magnitude factors of practical importance. By employing the computed constants, the effect of the electric-field magnitude factor and the heat-generation parameter as well as axial conduction on the local temperature profiles and Nusselt numbers were examined and are reported. (auth)

Geophysics

Refer also to abstracts 21789 and 21790.

22004 (CONF-661204–(Vol.1), pp 6.1-12) EXPLORATION OF THE MAGNETOSPHERE BY ANALYSIS OF HIGH-ALTITUDE NUCLEAR WEAPONS TEST DATA. Hodder, D. T.; Fowler, R. A.; Kert, J. (North American Aviation, Inc., Downey, Calif. Space and Information Systems Div.).

The results of a two year effort in reduction and analysis of geomagnetic perturbation data resulting from high-altitude nuclear weapons detonation are presented. As a result of these analyses, a theoretical model is derived based upon a magnetohydrodynamic (MHD) resonance, which explains the uniqueness of prominent electromagnetic effects of high-altitude nuclear detonations in the 0.1- and 1.0-cps frequency range. The resonance is formed in the region bounded by the two critical points at which the gradient of the Alfvén phase velocity changes sign. This is analogous to a series of strings (geomagnetic field lines) bounded at their extremes by the locus of critical points which form nearly spherical concentric surfaces at 300- and 3,000-km altitudes (Alfvén duct), with its central portion missing between ±35° geomagnetic latitude due to magnetic field lines not intersecting the upper boundary. The transverse (Alfvén) waves are guided along the field lines, encounter partial reflection at the critical surface maintain resonance for a time, and decay. At the lower boundary, the signal leaking out is converted into other MHD modes propagated downward through the exosphere and ionosphere, and degenerates to electromagnetic signals at the atmosphere interface. This model explains signal simultaneity, duration, frequency content, and harmonic structure. Due to the variation in the length of the field lines and Alfvén speed within the region, resonant frequencies vary according to the latitude at which the disturbance

is measured. Signal duration is related to energy dissipation rate. (auth)

22005 (CONF-661204-(Vol.1), pp 24.1-11) NEW APPROACHES FOR MAPPING OF THE "FIELD OF FLUCTUATIONS" BY ELECTROMAGNETIC TECHNIQUES. Paranjape, Sharad V.; Hu, Steve S. (Northrop Space Lab., Huntsville, Ala.).

Basic concepts regarding the fluctuating parameters of deep space, near-earth space, and the earth environment are formulated. Measurement philosophy for the determination of the statistical parameters of the random phenomena associated with these fluctuations is indicated. Some new approaches based on recent developments in the field of wind tunnel instrumentation are discussed. Details of certain promising features of these instruments are also given. Specific applications of the proposed electromagnetic techniques for measurements of random phenomena in the environmental conditions are outlined. (auth)

22006 ON THE PRODUCTION OF SPORADIC E NEAR THE GEOMAGNETIC POLE. Baird, G. A. (Bartol Research Foundation, Swarthmore, Pa.). Can. J. Phys., 46: 78-80(Jan. 1, 1968).

It has been suggested by several authors that some forms of sporadic E may be associated with proton precipitation. This note reports preliminary results of a calculation of the effects of low-energy protons on the ionosphere in the light of this suggestion. It was assumed that protons incident in the polar region arrive isotropically, and that their energy spectrum is of the form $J(>E) = J_0^{(-E/E_0)}$. It is pointed out that the proton energy flux observed by Sharp(1967) during high-latitude dayside satellite passes was about an order of magnitude smaller than that required to produce 5-Mc Es; however the shape of the spectrum is not inconsistent with the shape predicted by this study. (W.D.M.)

22007 ELECTRON FLUXES AT 1000-km ALTITUDE ASSOCIATED WITH AURORAL SUBSTORMS. Lin, W. C.; McDiarmid, I. B.; Burrows, J. R. (National Research Council of Canada, Ottawa). Can. J. Phys., 46: 80-3(Jan. 1, 1968).

In a recent paper based on Alouette I observations, McDiarmid and Burrows (1965) reported high-latitude electron spikes at 1000 km, on the right side of the Earth, and on lines of force presumably connected to the tail of the magnetosphere. The present note is an extension of the earlier work and reports occurrences of high-latitude electron fluxes extending for many degrees north of the normal nighttime boundary of the outer radiation zone; this high-latitude flux is associated with the expansion phase of a substorm as observed by riometers (Jelly 1968). (W.D.M.)

22008 A COMPARISON OF THE METHOD OF SIMILAR FADES AND THE METHOD OF MAXIMUM CROSS-CORRELATION OF ANALYSING THE IONOSPHERIC DRIFT RECORDS. Patel, C. M. (Physical Research Lab., Ahmedabad, India). Indian J. Pure Appl. Phys., 5: 450-2(Oct. 1967).

Analysis of the fading records of E region reflections of 2.6-Mc radio waves from the ionosphere over Ahmedabad made by the method of similar fades and by the method of maximum cross correlation between the fading records is presented. A close agreement is found between the results obtained by both methods. (auth)

22009 ANOMALOUS VARIATIONS IN PHASE PATH RECORDS. Reddi, C. Raghava; Rao, B. Ramachandra (Andhra Univ., Waltair, India). J. Atmos. Terrest. Phys., 29: 1603-10 (Dec. 1967).

Simultaneous records of amplitude and phase path of ionospherically reflected pulsed radio waves received on an E–W aerial under periodic fading conditions showed sudden discontinuities in the phase variations, when the amplitude was a minimum. Under random fading conditions also, the sudden discontinuities frequently observed in the phase variations were always accompanied by an amplitude minimum. It is shown that when two signals with a phase path difference changing continuously are received simultaneously, the resultant phase of the combined signal changes rather slowly, and shows a discontinuity when the difference passes through an angle of 180°. The phase path variations recorded at points separated by about 100 m sometimes showed variations in opposite directions. This is interpreted as due to the changes in the direction of arrival of the downcoming waves. (auth) (UK)

22010 ATTENUATION OF RADIO WAVES BY THE TROPOSPHERE OVER THE FREQUENCY RANGE 0.4 TO 10 GHz. Howell, T. F.; Shakeshaft, J. R. (Cambridge Univ., Eng.). J. Atmos. Terrest. Phys., 29: 1559-71(Dec. 1967).

New observations of the tropospheric attenuation at frequencies of 0.408 and 1.407 Gz were carried out by a source extinction method. A refraction correction, previously overlooked or made in the wrong sense, is discussed. Application to previous work indicates that agreement is obtained between theoretical and experimental values of the attenuation over the range of frequency from 0.4 to 10 GHz. (auth) (UK)

22011 AURORAL OVAL IN THE IGY AND IQSY PERIOD AND A RING CURRENT IN THE MAGNETOSPHERE. Feldstein, Y. I.; Starkov, G. V. (World Data Center, Moscow. Polar Geophysical Inst., Murmansk, USSR). Planet Space Sci., 16: 129-33 (Jan. 1968).

Investigation of auroral patterns from the IGY data showed that the atmospheric luminescence is observed most often along the auroral oval, displaced to the right side in relation to the geomagnetic pole. Various forms of auroras are located along the oval, depending on local time. The oval sizes change with the degree of geomagnetic activity. The edge location for the IGY and IQSY period is given. A possible reason for auroral oval displacement towards the equator in the years of solar activity maximum may be the effect of the ring current DR, the intensity of which was, on average, smaller in the years of solar activity minimum than in the IGY period. (UK)

22012 BEHAVIOUR OF UPPER ATMOSPHERE EMISSIONS DURING HIGH METEORIC ACTIVITY. Shefov, N. N. (Inst. of Physics of the Atmosphere, Moscow). Planet. Space Sci., 16: 134-6(Jan. 1968).

An analysis was made of the behavior of upper atmosphere hydroxyl emission which takes place at heights of 70 to 90 km covering the zone of the occurrence of noctilucent clouds (NCL). Observations were made in the infrared and optical regions of the spectrum. Measurements of the intensity and rotational temperature of the OH bands, as well as the intensity of the O_2 atmospheric band, during the appearance of NCL, show that the rotational temperature of the OH bands scarcely varies and has no regular pattern, while the intensity varies greatly during this period. Other emissions of the upper atmosphere were also studied. Results obtained confirm the hypothesis that in interplanetary space there are complex hydrocarbon compounds. (UK)

22013 DIURNAL ASYMMETRIES IN THE SUBPEAK ELECTRON CONTENT OF THE E AND F1 REGIONS. Brown, G. M.; Wynne, R. (University Coll. of Wales, Aberystwyth). J. Atmos. Terrest. Phys., 29: 1595-601(Dec. 1967).

Using expanded-scale ionograms obtained at Aberystwyth the integrated subpeak electron content of both the E and F1 regions was calculated at quarter-hourly intervals over the day for the summer period 1962–63. The absolute values obtained, and the mean diurnal variation for each layer, are compared with those expected for a Chapman profile. It is found that the diurnal curves are asymmetrical about noon, in opposite senses for the two layers, such that over the middle-day period the E-region content is elevated and the F1-region content depressed. Comparison with magnetic field data, and with the previously established changes in peak height and peak density arising from geomagnetic distortion of these layers, leads to the conclusion that the changes in subpeak content result directly from the perturbing influence of the S_q current system. It is shown that in the distortion of the electron density profile it is the change in h_m, rather than that in N_m, which determines the change in $\int N\,dh$ below the peak. (auth) (UK)

22014 DIRECTIONAL DEPENDENCY OF "SLOW TAIL" ELF ATMOSPHERIC WAVEFORMS. Hughes, H. G. (Navy Electronics Lab., San Diego, Calif.). J. Atmos. Terrest. Phys., 29: 1629-31 (Dec. 1967).

Additional measurements are presented which substantiate the directional dependency of nighttime "slow tail" elf waveforms reported earlier (Hughes, 1967). (auth) (UK)

22015 EFFECT OF ATMOSPHERIC WINDS ON THE HEIGHT OF THE F2-LAYER PEAK AT MIDDLE AND HIGH LATITUDES. King, J. W.; Kohl, H.; Pratt, R. (Radio and Space Research Station, Slough, Eng.). J. Atmos. Terrest. Phys., 29: 1529-39 (Dec. 1967).

The diurnal variations of the height of the F2-layer peak at middle and high latitudes appear to be strongly influenced by vertical ionospheric drifts due to the global atmospheric wind system produced by neutral-atmosphere pressure gradients. The average value of the diffusion coefficient at the layer peak, derived from the h_mF2 variations on the assumption that they are entirely caused by drifts, is 2.2×10^{16} cm^2 sec^{-1}, which is in good agreement with the appropriate theoretical value. (auth) (UK)

22016 EFFECT OF THE SOLAR ECLIPSE OF MAY 20, 1966, ON THE IONOSPHERIC ABSORPTION OF COSMIC NOISE ON 25 Mc/s. Ohle, K.-H.; Taubenheim, J. (Heinrich-Hertz-Inst., Berlin). J. Atmos. Terrest. Phys., 29: 1663-8(Dec. 1967).

Measurements of cosmic noise absorption (A2 method) on 25 Mc

in southeast Bulgaria during the solar eclipse of May 20, 1966, showed a significant decrease of absorption by about 0.5 dB at the time of maximum eclipse. The contribution of the D and E regions of the ionosphere to this eclipse effect was only 0.22 decibels, determined by a comparison with simultaneous Al absorption measurements (pulse reflection) on 3.86 Mc/s. There remains a significant eclipse effect which must be ascribed to a decrease of electron density in the lower F region. The eclipse variation of the maximum F2-layer electron density appears not to be representative for this F-region effect. (auth) (UK)

22017 HEATING OF THE UPPER ATMOSPHERE DURING GEOMAGNETIC DISTURBANCES. Krassovskii, V. I. (Inst. of Physics of the Atmosphere, Moscow). Nature (London), 217: 1136-7(Mar. 23, 1968).

During geomagnetic disturbances the upper atmosphere may be heated either by injected charged particles and electrojets, or by MHD waves and plasma oscillations. Early studies of the heating were based on some peculiarities of auroras at great heights. The detection of an increase in artificial satellite drag during geomagnetic disturbances gave further data on the phenomenon. Investigations of ordinary auroras by an interferometer method showed that the temperature of the upper atmosphere did not differ from that given in the 1965 Cospar International Reference Atmosphere for undisturbed conditions. The function of vibrationally excited NO and NO^+ molecules is discussed, both in regard to cooling of the upper atmosphere and decrease of daytime radio wave absorption in the D layer. If the result of interferometric investigations of the temperature during auroras is reliable, there are serious grounds for believing that heating of the upper atmosphere (below 200 km) due to injection of charged particles and electrojets cannot be important. The metastable atomic oxygen emission at 6300 Å, during large geomagnetic storms, is also discussed. Neither energetic, nor low-energy electrons, nor hot electron gas with a Maxwellian energy distribution can be a reason for the excitation of red emission at 6300 Å. Heating of the upper atmosphere by plasma oscillations or magnetohydrodynamic waves appears to be the only probable reason for red atomic oxygen emission at 6300 Å. The increase of artificial satellite drag during geomagnetic disturbances is interpreted in terms of heating of the upper atmosphere during which the height distribution of heat inflows corresponds to that typical of daytime ordinary undisturbed conditions. Twenty-seven day and semiannual variations of artificial satellite drag can also be associated with heating of the upper atmosphere by plasma oscillations or MHD waves which accompany geomagnetic disturbances and auroras. It is likely that, with further and more detailed determination of the heating processes, a small contribution from MHD and plasma wave absorption will be detected. (UK)

22018 INTENSE AURORAL ZONE X-RAY EVENT IN THE 4- TO 5-SEC PERIOD RANGE. Brown, R. R.; Weir, R. A. (Univ. of California, Berkeley). J. Atmos. Terrest. Phys., 29: 1611-18 (Dec. 1967).

During the magnetic activity following the September 2, 1966 PCA event an intense auroral zone x-ray pulsation event was observed in the 4 to 5-sec period range. Comparison of this event with the temporal features of micropulsations in the same period range does not support the suggestion that pulsating electron precipitation arises from processes directly involving micropulsation fields. (auth)

22019 IONOSPHERIC IRREGULARITIES AT ARECIBO, PUERTO RICO. Aarons, Jules (Air Force Cambridge Research Labs., Bedford, Mass.). J. Atmos. Terrest. Phys., 29: 1619-24 (Dec. 1967).

Nighttime observations of radio stars were made at four frequencies in the band 22 to 38 MHz with the 1000 foot reflector at Arecibo. Weak ionospheric irregularities were a consistent feature in the 21.00 to 04.00 LMT period. Observations were made in the fall of 1964 and the spring of 1965, when the sunspot number was low. The maximum scintillation activity took place at 01.00 LMT. The time of maximum was the same as that observed for the maximum occurrence of spread-F during low sunspot number years. By measuring scintillation index as a function of wavelength it was determined that the irregularity height was close to 300 km. In a related study during this time period satellite scintillations at 40 MHz were observed. It was shown that the weak ionospheric irregularities at night are uniform over a large range of latitudes. Scintillation indices increase rapidly at sub-auroral and auroral latitudes, such as Sagamore Hill, Massachusetts and Thyle, Greenland. (auth) (UK)

22020 LUNAR TIDES AT FIXED REAL HEIGHTS IN THE IONOSPHERE OVER AHMEDABAD. Sharma, R. P.; Rastogi, R. G. (Physical Research Lab., Ahmedabad, India). J. Atmos. Terrest. Phys., 29: 1641-6(Dec. 1967).

Lunar semi-monthly variations of the electron density at fixed real heights h of the ionosphere at noon over Ahmedabad during the period January 1963 to December 1965 were computed. During any of the seasons, the amplitude was found to increase uniformly with height above about 160 km, and the phase appeared to be constant with height. At any fixed height above 160 km the amplitude was largest during winter and least during summer. (auth) (UK)

22021 MAGNETOSPHERIC PROPAGATION OF VLF WAVES FROM FRANCE TO SOUTH AFRICA. Schoute-Vanneck, C. A.; Mezher, G. C. (Univ. of Natal, Durban, South Africa). J. Atmos. Terrest. Phys., 29: 1637-9(Dec. 1967).

An attempt was made to detect 16.8 kHz pulse signals propagated via the magnetosphere from Sainte-Assise (France) to Durban (South Africa), 1200 km from the magnetic conjugate point of the transmitter. The level of atmospherics set a limit of 5 μV/m to the minimum signal strength detectable with the apparatus used. Under the existing conditions no magnetospheric signal was detected. This result is shown to be compatible with theoretical field strength estimations. (auth) (UK)

22022 MORPHOLOGY OF THE VHF RADIO AURORA AT SUNSPOT MAXIMUM. III. MOVEMENT OF ECHOES. Unwin, R. S. (PEL Auroral Station, Omakau, New Zealand). J. Atmos. Terrest. Phys., 29: 1581-93(Dec. 1967).

A statistical analysis of the radial movement of auroral echoes in a direction 30°E of local magnetic south, observed at 55 Mc from Bluff in 1958, is presented. The mean geomagnetic time of changeover from negative (toward the radar) to positive directions of radial movement occurred earlier at greater ranges from the radar, that is at higher latitudes, but was independent of the level of magnetic disturbance. Mean negative radial velocities were independent of the level of disturbance, but mean positive radial velocities were strongly correlated. If the radial velocities looking along two directions are interpreted as components of a horizontal velocity in the echo region there is a difference of approximately 90° between the direction of movement and the direction of the horizontal magnetic disturbance vector under the echo region during the evening and early morning, but poor agreement between their magnitudes, except occasionally in the early morning. The results are in generally good agreement with previously published data from similar latitudes. (auth) (UK)

22023 NARROW FREQUENCY BANDS IN HYDROMAGNETIC EMISSIONS (Pc 1). Fraser-Smith, A. C. (Lockheed Research Lab., Palo Alto, Calif.). J. Atmos. Terrest. Phys., 29: 1541-57 (Dec. 1967).

The two most conspicuous features of hydromagnetic emissions (Pc1) are: (1) a rising frequency fine structure and (2) a series of narrow frequency bands. Whereas the fine structure appears well understood, the narrow frequency bands require explanation. Results presented indicate that the bands arise from a process closely related to that responsible for the fine structure; namely, the propagation to Earth along high latitude (60 to 70°) geomagnetic field lines of Alfvén (ion cyclotron) waves generated in the vicinity of the equatorial plane. In the case of the bands, however, a resonance process is also involved. Two resonance regions are identified along each field line and it is shown that for high latitude field lines the broad hydromagnetic resonances typical of the region below the Alfvén velocity maximum are actually split into a number of finer resonances. These narrow resonances are apparently high order harmonics of the simple field line resonance discussed earlier by other workers. The frequency spacing of the resulting narrow frequency bands thus depends closely upon the particular field line concerned, and decreases with increasing L value. (auth) (UK)

22024 OBSERVED CORRELATION BETWEEN THE OCCURRENCE OF SPORADIC E AND MAGNETIC ACTIVITY. Morgan, A. D. (Government Communications Headquarters, Cheltenham, Eng.). J. Atmos. Terrest. Phys., 29: 1633-5(Dec. 1967).

The daily correlation between the occurrence of sporadic E and magnetic activity is briefly investigated and results are presented for June and September 1966. The results tend to show a negative correlation, which is in keeping with the seasonal variation for both temporate latitude E_s and magnetic activity. (auth) (UK)

22025 OXYGEN EMISSION AT λ 6300 Å AND GEOMAGNETIC ACTIVITY. Truttse, Yu. L. (Inst. of Physics of the Atmosphere, Moscow). Planet. Space Sci., 16: 140-1(Jan. 1968).

In order to demonstrate dependence of the intensity of red oxygen emission at λ 6300 Å on the level of geomagnetic activity, an analysis was made of the extensive photometric observational material

obtained by the international network of stations during the IGY (June 1957 to December 1959). (UK)

22026 PROPAGATION OF MICROPULSATION WHISTLERS THROUGH A POSSIBLE REGION OF EVANESCENCE IN THE MAGNETOSPHERE. Burman, R. (Victoria Univ. of Wellington, New Zealand). Planet. Space Sci., 16: 137-9(Jan. 1968).

While investigating the propagation of micropulsation whistlers, Dowden (Planet. Space Sci., 14: 1273 (1966)) considered transmission through a region containing a zero and a singularity of the refractive index. In this note, the problem is discussed further; in particular, Dowden's use of the WKB method is substantiated. (UK)

22027 RELATION OF AURORAL "FLAT TYPE" SPORADIC-E TO MAGNETIC DISTURBANCE. Schaeffer, R. C. (Univ. of Adelaide). J. Atmos. Terrest. Phys., 29: 1511-17(Dec. 1967).

It is shown that "flat type" sporadic-E (E_{sf}) observed in the auroral zones can be classified into two types. Type-I E_{sf} is apparently the same as that observed in middle latitudes and is unrelated to magnetic disturbance. The occurrence of Type-II E_{sf}, on the other hand, is distinct in that it tends to precede local auroral storm events. The diurnal and seasonal variations of the two types are described. (auth) (UK)

22028 RELATIONSHIP BETWEEN THE IONOSPHERIC EQUATORIAL ANOMALY AND THE E-REGION CURRENT SYSTEM. Dunford, E. (Radio and Space Research Station, Slough, Eng.). J. Atmos. Terrest. Phys., 29: 1489-98(Dec. 1967).

Data obtained from the topside sounder satellite Alouette 1 and from ionospheric and magnetic ground stations were used to investigate the validity of the Martyn theory for the formation of the equatorial anomaly. Day-to-day changes in the anomaly and in the magnetic variations were compared using scatter plots and correlation coefficients. It is concluded that a highly significant correlation exists between the magnitude of the equatorial anomaly and the strength of the E-region currents flowing in the equatorial region. (auth) (UK)

22029 RELATION BETWEEN MAGNETIC ACTIVITY AND SPREAD-F AT KODAIKANAL. Kumar, V. R. Jagath; Raju, P. T. Sanyasi; Rao, B. Ramachandra (Andhra Univ., Waltair, India). J. Atmos. Terrest. Phys., 29: 1669-72(Dec. 1967).

The correlation between nighttime values of spread-F indices, magnetic K-indices, and $h'_{max}F$ values for Kodaikanal are examined for a half solar cycle. Cross correlograms for spread-F indices and magnetic K-indices show that the variations of occurrence of spread-F echoes lag behind the variations of K-index by a period varying from zero in the sunspot maximum period to 5 days in the sunspot minimum period. A similar effect is observed between $h'_{max}F$ variations and K-index variations, but with lesser delay. A strong positive correlation is observed between spread-F indices and $h'_{max}F$ values without any time lag throughout the half solar cycle. (auth) (UK)

22030 STUDY OF THE EFFECTS ON THE IONOSPHERE OF THE SOLAR ECLIPSE OF MAY 30, 1965 FROM SOUNDING OBSERVATIONS IN POLYNESIA. Bourdila, A. M. (Centre National d'Etudes des Telecommunications, Saclay, France). J. Atmos. Terrest. Phys., 29: 1499-1509(Dec. 1967). (In French).

Many valuable ionograms were obtained from two vertical sounding stations located in the Society Islands—the first station at Tahiti (fraction of obscured Sun's disk at ground level 89/100) and the second at Maupelia (fraction of obscured Sun's disk at ground level 99/100). These ionograms permitted real height determination by Schmerling's method. Electron production rate, recombination and attachment coefficients are deduced from consideration of the curves showing electron density variation as a function of time. Blanketing of the ionizing sources during periods of zero sunspot activity is a well-known phenomenon, and can be assumed to give rise to "peculiar" data. (auth) (UK)

22031 SUNSPOT CYCLE AND THE QUASI-BIENNIAL STRATOSPHERIC OSCILLATION. Berson, F. A.; Kulkarni, R. N. (CSIRO, Aspendale, Australia). Nature (London), 217: 1133-4(Mar. 23, 1968).

Observations from the southern hemisphere indicated an attenuation of the oscillation in 1963-64. The 24 to 26 month cycles of wind and temperature in the lower stratosphere, and of total ozone, weakened or vanished after a series of pronounced cycles in 1955-62 (years characterised by high sunspot activity). During recent years quasi-biennial modes reappeared with a reversed phase. The breakdown of the oscillation in 1963 was linked with a reduction of direct solar radiation in the southern hemisphere following the injection of volcanic dust. It had been noted from observations made from 1939-63 that breaks and phase shifts occurred in the quasi-biennial mode about half-way between sunspot maxima. Since 1964 was a year of sunspot minimum an extraterrestrial influence on the oscillation is suggested, and further evidence is presented to support a connection of the oscillation with sunspot cycle, including observations in the tropics north of the equator. An association of amplitude fluctuation in the quasi-biennial oscillation of temperature and ozone with the single (~11 yr) sunspot cycle suggests the influence of variable solar corpuscular emission. It is shown that variations in solar emission associated with the double (22 yr) sunspot cycle provide a mechanism by which the frequency of a biennial cycle can be shifted. It is pointed out that angular modulation is a feasible mechanism, whereas amplitude modulation would require additional energy for the oscillation. It is noteworthy that low amplitude wind cycles with a 13 month period, detected in data from the lower tropical stratosphere, can be interpreted in terms of modulation of a weak annual wave present in the tropical belt. (UK)

22032 LONGITUDINAL SPREAD OF Pc1 MICROPULSATIONS IN THE MAGNETOSPHERE. Knaflich, H. B. (Boeing Scientific Research Labs., Seattle); Kenney, J. F.; Hessler, V. P. Nature (London), 217: 1134-6(Mar. 23, 1968).

It is stated that one of the important problems concerned with Pc1 micropulsation research is to determine what portion of the magnetosphere is involved in the propagation of an individual structured Pc1 event. It is generally recognized that these micropulsations propagate backwards and forwards in a dispersive medium between conjugate hemispheres guided by the Earth's magnetic field, but it is not known whether the waves are constrained to propagate along a single field line or whether they can spread out along an appreciable portion of a magnetic shell. It is reasonable to assume, however, that since trapped particles undergo longitudinal drift, a structured Pc1 micropulsation may spread out even if it started on a particular field line. Dispersion measurements used to locate the latitude where the field lines or shells intercept the Earth's surface cannot be used to determine longitude, and resort must be made to interstation comparison of data. Available data, however, are not sufficiently accurate to allow an unambiguous measurement of the longitude or spread in longitude of the magnetospheric portion of the path. Comparison of the signal strength or occurrence rates at different stations may also be impossible since the final portion of the propagation path involves an ionospheric duct with unknown attenuation parameters. These difficulties are discussed in detail. Types of interaction that may be present at the interface between the magnetosphere and ionosphere are illustrated. Progress can be made towards solution of the longitude problem from recent advances in the interpretation of Pi1 events known as "irregular pulsations of diminishing period;" structured Pc1 and Pi1 events have the same frequency range, so that the effects of the ionosphere on these two different classes of guided micropulsations should be similar. (UK)

22033 NIGHT AIRGLOW INTENSITY VARIATIONS IN THE [O I] 5577 A, [O I] 6300 A, AND NaI 5890-96 A EMISSION LINES. Smith, L. L. (Environmental Science Services Administration, Boulder, Colo.); Steiger, W. R. J. Geophys. Res., 73: 2531-8 (Apr. 1, 1968).

The results are presented from a study of the intensity variations of the principal night airglow emission lines [O I] 5577Å, [O I] 6300Å, and the Na doublet 5890-96Å. Diurnal, seasonal, and solar-cycle variations were investigated and are compared for two stations: Kitt Peak and Haleakala. The data were obtained from narrow-band interference filter photometers, all of similar design. (W.D.M.)

22034 DISCUSSION OF PAPER BY E. N. PARKER, "CONFINEMENT OF A MAGNETIC FIELD BY A BEAM OF IONS." Stubbs, H. E. (Mount Auburn Research Associates, Inc., Cambridge, Mass.). J. Geophys. Res., 73: 2539-40(Apr. 1, 1968).

Recently Parker [1967] discussed the confinement of a magnetic field by a streaming plasma. He considered an idealized, one-dimensional case where the electric charges were everywhere neutralized by a pervasive background plasma so that the electric field was everywhere nil. Parker's principal conclusion was that when the streaming plasma had a velocity component parallel to the magnetic field, there existed no steady-state solution that was effective in confining the magnetic field. At least for the idealized problem, this conclusion is incorrect. In this letter, a consistent steady-state solution that confines the field is indicated. A reply by Parker is included. (W.D.M.)

22035 CRUDE ESTIMATE OF THE RELATION BETWEEN THE SOLAR WIND SPEED AND THE MAGNETOSPHERIC ELECTRIC FIELD. Vasyliunas, Vytenis M. (Massachusetts Inst. of Tech., Cambridge). Contract AT(30-1)-2098. J. Geophys. Res., 73: 2529-30(Apr. 1, 1968). (MIT-2098-394).

It is shown that the electric field has the same Kp dependence as the solar wind speed. This suggests that the two quantities are proportional. A rough relation is obtained between the solar wind speed and the convective electric field on the dusk meridian. For not too large Kp, this relation is roughly independent of Kp. (W.D.M.)

22036 AN END EFFECT ASSOCIATED WITH CYLINDRICAL LANGMUIR PROBES MOVING AT SATELLITE VELOCITIES. Bettinger, Richard T.; Chen, A. Anthony (Univ. of Maryland, College Park). J. Geophys. Res., 73: 2513-28(Apr. 1, 1968).

An anomaly in the volt–ampere characteristic of the cylindrical Langmuir probe carried aboard the Explorer 17 satellite has been observed. It consists of a substantial enhancement of the positive ion current that is related to the spatial aspect of the probe. This phenomenon can be explained as an end effect that becomes important as the angle (θ) between the axis of the probe and the velocity vector of the satellite becomes small. An analytical expression for this end current as a function of θ is derived. This expression fits the flight data within the experimental error. The effect may be utilized to experimentally obtain information on the ion temperature and its mass distribution as well as the dimension of the sheath about the probe. It is also suggested that this effect might be utilized to accurately detect the velocity vector of the satellite. (auth)

22037 EVALUATION OF GEOMAGNETIC HARMONIC SERIES FOR 1100-KILOMETER ALTITUDE. Heuring, F. T.; Zmuda, A. J.; Radford, W. E.; Verzariu, P. (Johns Hopkins Univ., Silver Spring, Md.). J. Geophys. Res., 73: 2505-11(Apr. 1, 1968).

Magnetic intensities obtained with satellite 1964-83C are used to evaluate six harmonic sets being considered in relation to an International Geomagnetic Reference Field. As the number of terms in each series increases, the rms difference between observed and computed values decreases first rapidly, and then slowly, but ultimately reaches a plateau value. The GSFC 12/66 field of Cain et al., gives the best fit to the observations with the rms residual ultimately equaling 67 γ for geomagnetic intensities in the range 15,000 to 31,000 γ. (auth)

22038 SCALAR MAGNETIC INTENSITY AT 1100 KILOMETERS IN MIDDLE AND LOW LATITUDES. Zmuda, A. J.; Radford, W. E.; Heuring, F. T.; Verzariu, P. (Johns Hopkins Univ., Silver Spring, Md.). J. Geophys. Res., 73: 2495-2503(Apr. 1, 1968).

With a Varian RB-85 magnetometer, satellite 1964-83C measured the scalar magnetic intensity in middle and low latitudes at about 1100 km. The differences between observed and computed values show quasi-sinusoidal spatial variations indicative of errors in the harmonic coefficients with $n \approx 3$, $m \approx 4$, and $m \approx 6$. The isodynamic lines in the South Atlantic anomaly form closed loops around a center at 20°S and 45°W. In the recovery phase of the storm of 1312 UT, April 17, 1965, a decrease in intensity occurs that is comparable to the decrease at the Earth's surface. (auth)

22039 RELATIVE CHANGES ON LOWER IONOSPHERE CONDUCTIVITY GRADIENTS DURING SID EVENTS. Kaufmann, Pierre; Mendes, Aracy M. (Mackenzie Univ., Sao Paulo, Brazil). J. Geophys. Res., 73: 2487-93(Apr. 1, 1968).

The occurrence of sudden ionospheric disturbances is studied in relation to changes in the conductivity parameter and the conductivity gradient in the lower ionosphere. The analysis is based on phase and amplitude data from a great number of such events measured at several very low frequencies. The change of the conductivity parameter was found to be more important as the SID affects deeper regions. The results also suggest that during these anomalies the ionospheric conductivity gradient is reduced, generally by small amounts. Such disturbed gradients may be determined if initial conditions for daytime normal gradient, and for collision frequencies above the D region, are known. A first estimate shows that, for the majority of the events selected, the new gradient changes from the normal daytime value of 0.30 to 0.28 km^{-1}. The existence of special kinds of SID is discussed; they produce an important modification in the gradient and a relatively small height variation for the earth–ionosphere waveguide upper boundary. (auth)

22040 INCOHERENT BACKSCATTER STUDY OF ELECTRON CONTENT AND EQUIVALENT SLAB THICKNESS. Mahajan, K. K.; Rao, P. B.; Prasad, S. S. (Cornell Univ., Arecibo, Puerto Rico). J. Geophys. Res., 73: 2477-86(Apr. 1, 1968).

Results of electron content and equivalent slab thickness obtained from radar backscatter measurements at Arecibo (18.4°N, 67°W) are presented and examined in the light of other simultaneously observed parameters, such as the height of the F-layer peak and electron and ion temperatures. There is a considerable day-to-day variability both in the electron content and the equivalent slab thickness. The daytime electron content shows a strong positive correlation with the height of the F-layer peak, hmF2, which seems to be due to decrease in the integrated loss rates with increasing peak height. The post sunset decay of the electron content provides a mean effective attachment coefficient of 8×10^{-6} sec^{-1}. The post midnight enhancements, observed mainly during the winter nights, require downward electron fluxes of about 2.5×10^{12} m^{-2} at the height of 700 km. The slab thickness during the nighttime shows a strong dependence upon hmF2 and is very closely related to the neutral scale height at the peak. The daytime slab thickness, however, is controlled jointly by the neutral scale height and the extent of thermal nonequilibrium. (auth)

22041 VHF CHARACTERISTICS OF THE TRANSEQUATORIAL IONOSPHERE. Bowen, E. D. (Smith Research Associates, San Diego, Calif.); Fay, W. J.; Heritage, J. L. J. Geophys. Res., 73: 2469-76(Apr. 1, 1968).

A program for studying transmissions at 34, 45, 54, and 77 MHz from Okinawa to receiving sites at Darwin and Fiji was conducted from December 1965 to June 1966. The Okinawa–Darwin terminals were located at magnetic dip conjugate points, while the Okinawa–Fiji path was skewed 36° with the magnetic equator. Records indicated the regular reception of two modes, an hf mode received at both sites on 34 MHz, and a vhf mode received at the Darwin site on frequencies as high at 77 MHz. The hf mode was a daily phenomenon, and test results suggest a trapezoidal path. The vhf mode occurred regularly between 1900 and 0200 hours, path midpoint time, during the most active season, the March equinox. The vhf mode was characterized by rapid fading of the signal envelope. Transmission path loss exhibited a $\lambda^{4.5}$ dependence with severe attenuation expected above 77 MHz. Measurements of elevation angle and travel time delay between the normal and vhf mode indicate a field-guided path for the vhf mode. (auth)

22042 FARADAY ROTATION MEASUREMENTS OF ELECTRON CONTENT NEAR THE MAGNETIC EQUATOR. Rufenach, Clifford L.; Nimit, Vichai T.; Leo, Robert E. (Stanford Research Inst., Menlo Park, Calif.). J. Geophys. Res., 73: 2459-68(Apr. 1, 1968).

At the Electronics Laboratory of the Military Research and Development Center, Bangkok, Thailand (13.7°N latitude, 100.1°E longitude), Faraday rotation observations of the 54-MHz signal from the Transit 4A (1961 Omicron 1) satellite were made during 10 months of a sunspot minimum period (1964). The satellite has an essentially circular orbit with an inclination of 67° and a spin-stabilized linear-polarized antenna. In this paper, two methods of analysis, involving rotation rate and total number of rotations, are applied to the Bangkok observations. The rotation-rate method is used to determine the electron content when the angle between the ray path and the geomagnetic field is 90° (transverse position). The total-rotations method is used to determine the latitudinal variations of the electron content for five selected satellite passes from a joint analysis of observations at three stations, Singapore, Bangkok, and Hong Kong. A comparison of the calculated critical frequency with observed ionosonde critical frequencies at Singapore, Bangkok, and Macao shows some evidence that the equivalent slab thickness may be considered independent of latitude near the magnetic equator. (auth)

22043 COMPARISON OF FARADAY AND DOPPLER METHODS OF OBTAINING IONOSPHERIC ELECTRON CONTENT. Rao, N. Narayana; Yeh, K. C. (Univ. of Illinois, Urbana). J. Geophys. Res., 73: 2447-58(Apr. 1, 1968).

The most commonly used methods for the determination of the total electron content of the ionosphere from observations of orbiting satellite transmissions have been (a) single-frequency Faraday rotation, (b) differential Faraday rotation, and (c) differential Doppler. This paper compares these three methods and in particular the last two by obtaining continuous curves of electron content under a variety of conditions from analysis of Faraday rotation and differential Doppler data of signals from the Beacon Explorer satellites BE-B and BE-C. It is found that there may be 5 to 10% discrepancies in the absolute values of electron content derived by the differential Faraday and differential Doppler methods. However, content variations obtained by both methods are found to be consistent even during the passage of traveling disturbances. (auth)

22044 TOPSIDE SPREAD F AT MIDLATITUDES. Dyson, P. L. (Goddard Space Flight Center, Greenbelt, Md.). J. Geophys. Res., 73: 2441-6(Apr. 1, 1968).

The occurrence of topside spread F at midlatitudes was studied using Alouette 1 ionograms recorded at Woomera, Australia. Occurrences are generally higher at night and during local winter. Comparison with other observations of topside spread F indicates

that there is a worldwide solar influence in the seasonal variations in the incidence of spread F. Irregularities causing ducting and scattering spread F usually occur together in patches extending in the N–S direction for at least 250 km and often for more than 1300 km during the night. The occurrence characteristics of topside refractive irregularities are similar to those of traveling ionospheric disturbances in the F_2 region. (auth)

22045 IMPORTANCE OF ASSOCIATIVE DETACHMENT AND DISSOCIATIVE ATTACHMENT IN THE LOWER IONOSPHERE AS SHOWN BY LF RADIO MEASUREMENTS. Doherty, R. H. (Inst. for Telecommunication Sciences and Aeronomy, Boulder, Colo.). J. Geophys. Res., 73: 2429-40(Apr. 1, 1968).

Ozone and atomic oxygen concentrations between 50 and 70 km are compared with phase and amplitude measurements of oblique-incidence lf pulse signals for diurnal and seasonal periods. Phase measurements made during a solar eclipse follow an identical pattern to one for a predicted ozone concentration at the reflection height, including an overshoot effect after the end of the eclipse. A slow enhancement in the lf pulse amplitude following daily sunset compares with a slow increase in the ozone concentration at the same time. Certain effects produced by solar flares also suggest a dependence on the O and O_3 concentrations. A correlation between the ozone and atomic oxygen concentration and the phase or amplitude effects of the lf signal would be expected if these constituents affected the electron concentration. Three possible ways that the electron concentration could be influenced by ozone or atomic oxygen are indicated by the reactions $O_2^- + O \rightarrow O_3 + e$, $O^- + O \rightarrow O_2 + e$, and $e + O_3 \rightarrow O_2 + O^-$. All these reactions have been observed in the laboratory with reaction rates ranging from 4×10^{-11} to 4×10^{-10} cm^3/sec, although it now appears that the electrons were not thermalized in the $e + O_3 \rightarrow O^- + O_2$ measurement, and, therefore, this rate may be considerably smaller. These reactions involving the neutral ozone and atomic oxygen concentrations all tend to reduce the electron concentration with increased O_3 and decreased O. This would increase the electron concentration during the day and decrease it at night and during an eclipse in agreement with the observed lf phase and amplitude variations, as well as a number of more direct ionospheric measurements. (auth)

22046 METASTABLE $O_2(^1\Delta)$ AS A MAJOR SOURCE OF IONS IN THE D REGION. Hunten, Donald M.; McElroy, Michael B. (Kitt Peak National Observatory, Tucson, Arizona). J. Geophys. Res., 73: 2421-8(Apr. 1, 1968).

It is pointed out that $O_2(a^1\Delta_g)$ can be ionized by the wavelength band 1027 to 1118 Å, parts of which can penetrate below 70 km. It appears that this source is able to explain the presence of O_2^+ ions in the D region. Quantitative estimates of the production rates are made; they are comparable to those available for NO^+ from NO. The concentrations of metastable O_2 were taken from the results of a recent dayglow flight. It is also suggested that the most important source of NO is the reaction of $O_2(^1\Delta)$ with N, which could be 3×10^6 faster than the corresponding reaction involving unexcited O_2. (auth)

22047 SYNTHETIC MODEL OF THE MAGNETOSPHERE BOUNDARY. Blum, Ronald (Univ. of Chicago). J. Geophys. Res., 73: 2411-19(Apr. 1, 1968).

A mathematical representation is devised that describes earlier approximate solutions to the idealized solar wind–geomagnetic field boundary for both perpendicular and parallel orientations of the geomagnetic dipole relative to the solar wind direction. The description agrees with both solutions to within a maximum error of 2.5% in the perpendicular case (average error 0.5%), and 3.5% in the parallel case (average error 1.4%), and is in accord with the formulation of the idealized problem. It is shown how this description may be used as a starting point to estimate the magnetospheric boundary for any orientation. (auth)

22048 PLASMA AND MAGNETIC FIELD OBSERVATIONS DURING THE MAGNETOSPHERE PASSAGE OF PIONEER 7. Lazarus, A. J. (Massachusetts Inst. of Tech., Cambridge); Siscoe, G. L.; Ness, N. F. J. Geophys. Res., 73: 2399-2409 (Apr. 1, 1968).

Data are presented from simultaneous measurements of magnetic field and the electron component of the plasma in the near geomagnetic tail (out to 40 R_E) during the outbound passage of Pioneer 7 on August 17 and 18, 1966. A quasi-static model of the geomagnetic tail based on a balance of particle and field pressures is found to be in general agreement with the data. Pressure balance was maintained even through the single well-defined traversal of the neutral sheet. During this traversal the electron concentration remained approximately constant, but the thermal energy increased to compensate for the reduced field pressure. Typical electron number densities and thermal speeds in the plasma sheath were 0.5/cm^3 and 10^7 m/sec. The proton pressure in the plasma sheath inferred from the pressure balance model was 1 to 3 times greater than the electron pressure. A possible second crossing of the neutral sheet was observed near the magnetopause. A period of low particle flux is found to correlate well with the observation of a geomagnetic bay event. (auth)

22049 ENERGETIC ELECTRONS OF TERRESTRIAL ORIGIN UPSTREAM IN THE SOLAR WIND. Anderson, K. A. (Univ. of California, Berkeley). J. Geophys. Res., 73: 2387-97(Apr. 1, 1968).

Fluxes of energetic electrons of terrestrial origin are frequently found beyond the bow shock on the sunward side of the Earth. The duration of individual events is from less than a minute up to several minutes, but they tend to occur in clusters lasting as long as several hours. Their flux is usually a few hundred cm^{-2} sec^{-1}, but occasionally it reaches 3×10^4 cm^{-2} sec^{-1} for electrons > 40 keV. The upstream electron spikes are associated with rapid motion of the bow shock. The best interpretation of upstream spikes is that they are simply electrons moving up interplanetary field lines from the magnetosheath just behind the shock where they originated as bow shock spikes. (auth)

22050 HYDROMAGNETIC DISTURBANCES OF 3- TO 15-MINUTE PERIOD ON THE MAGNETOPAUSE AND THEIR RELATION TO BOW SHOCK SPIKES. Anderson, K. A. (Univ. of California, Berkeley); Binsack, J. H.; Fairfield, D. H. J. Geophys. Res., 73: 2371-86(Apr. 1, 1968).

Data from IMP 2 magnetopause crossings were analyzed to reveal the character of the motion of the magnetospheric boundary. This boundary was found to be almost always in motion. The spatial amplitudes vary from roughly 0.2 to 2.2 R_E, and the motion is sometimes periodic. The characteristic times of the motion usually range from 3 to 15 minutes. Some times longer period motions are encountered, probably owing to solar wind pressure changes. The 3- to 15-minute motions are believed to be due to hydromagnetic disturbances on the magnetopause. The existence of these large-amplitude waves on the magnetopause shows that this is not a stable boundary, but the relevant instability cannot be established by the present experiment. However, the magnetopause motions can be shown to be coherent over distances of the order of 10 R_E, since the bow shock motions measured on the same satellite pass are found to have well-correlated amplitudes and characteristic times. Further evidence for the association of energetic electron bow shock spikes with motions of the magnetopause is given. A further experimental result is that the intense bow shock electron spikes lie in the magnetosheath just behind the bow shock. It is suggested that the origin of the electron spikes is in dissipation of hm wave energy. (auth)

22051 MICROBURST PHENOMENA. 3. AN ASSOCIATION BETWEEN MICROBURSTS AND VLF CHORUS. Oliven, M. N.; Gurnett, D. A. (Univ. of Iowa, Iowa City). J. Geophys. Res., 73: 2355-62(Apr. 1, 1968).

Observations made with the Injun 3 satellite of bursts of precipitating $E_e \geq 40$-keV electrons and of vlf chorus emission have revealed their simultaneous occurrence. Observed microbursts are always accompanied by a group of vlf chorus emissions; chorus is not necessarily accompanied by microbursts. The maximum region of microburst occurrence from 0400 ≤ magnetic local time ≤ 1300 and 65° ≤ invariant latitude ≤ 70° lies well within the maximum region of chorus emissions from 0300 ≤ magnetic local time ≤ 1500 and 55° ≤ invariant latitude ≤ 75°. It is not generally possible to find a one-to-one (burst to burst) correspondence between individual microbursts and vlf chorus bursts. (auth)

22052 MICROBURST PHENOMENA. 2. AURORAL-ZONE ELECTRONS. Oliven, M. N. (Univ. of Iowa, Iowa City); Venkatesan, D.; McCracken, K. G. J. Geophys. Res., 73: 2345-53(Apr. 1, 1968).

Observations made during a high-time-resolution mode of operation of the Injun 3 satellite have identified electrons comprising auroral-zone microbursts, the parent phenomenon of the microburst x-ray fluxes observed by balloon-borne instruments. These electron bursts, detected in the $E_e \geq 40$ keV (180°) (precipitating) detector and less frequently in the $E_e \geq 40$ keV (90°) (trapped) detector, have time profiles whose detailed character is similar to those of the daughter bremsstrahlung x-ray bursts and exhibit typical peak fluxes of $J_0(E_e \geq 40 \text{ keV}) \sim 3 \times 10^6$ electrons cm^{-2} sec^{-1} ster^{-1} in the 180° detector. Statistical studies of data from the entire satellite lifetime reveal microburst occurrence predominantly in the regions of 6 ≤ L ≤ 8.5 and 4:30 ≤ magnetic local time ≤ 12:30. Detailed statistical distributions of microburst occurrence as functions of local time and L are presented. (auth)

22053 MICROBURST PHENOMENA. 1. AURORAL-ZONE X RAYS. Venkatesan, D (Univ. of Calgary, Alberta); Oliven,

M. N.; Edwards, P. J.; McCracken, K. G.; Steinbock, M. J. Geophys. Res., 73: 2333-43(Apr. 1, 1968).

High-time resolution x-ray equipment flown from Fort Churchill, on August 11, 1965, provides evidence for species of auroral-zone x-ray microbursts with rise times of 20 to 30 msec. These microbursts are characterized by a rise of the form $1 - e^{-t/\tau_R}$, where τ_R is about 30 msec, and a decay of the form of e^{-t/τ_D}, where τ_D is about 200 msec, and a typical peak flux for the largest events of $J_0(E_{x\ ray} > 60\ keV) \sim 10^2$ photons cm^{-2} sec^{-1} at 10 g/cm^2. An episode of these rapidly rising bursts was observed in the early morning hours (after 4:30 local time), and an episode of the more common slower rising (temporally more symmetric) microbursts began after 9:30 local time. The fast rise times and the lack of dispersion $\gtrsim$10 msec in the x-ray bursts observed at different energies imply restrictions on the nature and propagation of the parent electron bursts. (auth)

22054 AURORAL ELECTRON ENERGY SPECTRA. Ogilvie, K. W. (Goddard Space Flight Center, Greenbelt, Md.). J. Geophys. Res., 73: 2325-32(Apr. 1, 1968).

Observations of differential energy spectra of electrons above a weak aurora at Fort Churchill are presented. Measurements were made at altitudes between 180 and 250 km using an electrostatic analyzer and channeltron detector over the energy range 10 eV to 10 keV. It is shown that below about 100 eV scattering from the rocket was pronounced. Although between 1 and 10 keV the spectra can be well represented by power-exponential functions with maxima in the region 1 to 4 keV, between 1 keV and 100 eV the flux rises toward lower energies. An estimate of the number of secondaries in the energy region 100 eV to 1 keV generated by the higher energy primaries is made, and it proves to be too small to explain the observed electron flux at low energies. This flux is shown to vary so little with altitude that it is likely to be due to ambient electrons accelerated by electric fields. (auth)

22055 OBSERVATIONS OF A NEAR MONOENERGETIC FLUX OF AURORAL ELECTRONS. Evans, David S. (Goddard Space Flight Center, Greenbelt, Md.). J. Geophys. Res., 73: 2315-23(Apr. 1, 1968).

Rocket-borne observations were made of a nearly monoenergetic beam of electrons in association with a prebreakup auroral display. The characteristic energy of this beam was about 4 keV and was very stable over a 150-second period of time. The nature of this energy spectra strongly suggests that the electron energization was by the electric fields associated with some static 4-keV potential difference in the magnetosphere. A model in which this potential was established directly along a magnetic field line cannot be uniquely excluded by these observations but is discounted on other grounds. The alternative is a model in which the required electric field is transverse to the magnetic field lines. Such electric fields are known to exist and have been measured directly. Energization of low-energy electrons by an electric field of this geometry would appear to require that these electrons be stably trapped on closed lines of magnetic force, the energization occurring by virtue of gradient and line curvature drift across equipotential lines. It is this process, which is similar to that proposed by Taylor and Hones (1965), that is believed to have produced the auroral particles observed in this aurora. The electrical potential differences known to be available in the magnetosphere although sufficient to produce these 4-keV electrons are inadequate to produce the 100-keV electrons seen in association with the aurora, thus implying the existence of more than one acceleration mechanism. (auth)

22056 DIRECT MEASUREMENT OF AURORAL ALPHA PARTICLES. Whalen, B. A.; McDiarmid, I. B. (National Research Council of Canada, Ottawa). J. Geophys. Res., 73: 2307-13(Apr. 1, 1968).

A rocket-borne magnetic spectrometer capable of separating singly charged alpha particles and protons with energies greater than 50 keV has been flown into a moderate auroral substorm at Fort Churchill, Manitoba. The measurements were carried out in a Black Brant VB rocket at altitudes up to 360 km. Below this altitude a beam of 50-keV alpha particles incident on the atmosphere will be near a state of charge equilibrium in which 30% of the alpha particles will be singly charged and about 70% neutral. Throughout the rocket flight, the spectrometer detected an appreciable flux of alpha particles. Typical measured intensities of precipitating electrons (>20 keV), protons (>50 keV), and alpha particles (>50 keV) were 10^6 cm^{-2} $ster^{-1}$ sec^{-1}, 1.4×10^5 cm^{-2} $ster^{-1}$ sec^{-1}, and 2.6×10^4 cm^{-2} $ster^{-1}$ sec^{-1}, respectively. The alpha particle to proton ratio varied from approximately 0.06 to 0.3 during the flight with an estimated uncertainty of no more than a factor of 2. The α/p ratio measured here, when compared to measured solar wind values, suggests that the "thermalization" process in the magnetosheath produces alphas and protons of equal velocity rather than equal energy distributions. (auth)

22057 SIMULTANEOUS OBSERVATION OF ELECTRON FLUXES, IONIZATION, AND LUMINOSITY IN AN AURORA. Matthews, D. L. (Univ. of Maryland, College Park); Clark, T. A. Can. J. Phys., 46: 201-9(Feb. 1, 1968).

Electron energy spectra, number density of ambient electrons, and 5577 Å luminosity were measured in a rocket which passed through a well-defined westward-moving auroral band embedded in a widespread diffuse glow. In the band there was excellent spatial correlation among the electron number density, the luminosity as seen from both the ground and the rocket, and the electron flux of energy 1 to 7 keV. A peak of higher-energy electrons trailed the band by ~10 km. The electron fluxes appeared to be not quite sufficient to account for the observed electron number density, still less for the luminosity. Fluxes of electrons having energies of the order of 100 eV were observed, too large and too uncorrelated with the higher-energy electron fluxes to be secondaries produced in the atmosphere by the electrons of higher energy. Since 100-eV electrons cannot penetrate from above to such heights ($\lesssim$140 km), there is a suggestion that they must have been locally accelerated. When these electrons are included in the calculations, it is possible under certain assumptions to obtain quantitative agreement between electron flux, electron density, and 5577 Å photon production in the diffuse glow. (auth) (Canada)

22058 A PROPOSED MODEL FOR THE INTERNATIONAL GEOMAGNETIC REFERENCE FIELD, 1965. Cain, Joseph C.; Hendricks, Shirley J.; Langel, Robert A.; Hudson, William V. J. Geomagnet. Geoelec., 19: 335-55(1967).

A best current model of the main geomagnetic field is presented as a response to a need for an "International Geomagnetic Reference Field." This model is described by a series of 120 spherical harmonic coefficients and their first and second time derivatives from an epoch 1960.0. It was derived from a sample of all magnetic survey data available from the interval 1900–1964 plus a recent global distribution of preliminary total field observations from the OGO-2 (1965-81A) spacecraft for epoch 1965.8. A duplicate data selection was made and the resulting field model compared with the first to help evaluate the minimum error. It was noted that rms difference between the two models was about 30 γ in the force components, 0.04° in dip and 0.3° in declination at the Earth's surface for 1965.0. (auth)

22059 WORLDWIDE SIMULTANEITY OF OCCURRENCE OF A Q-TYPE ELF BURST IN THE SCHUMANN RESONANCE FREQUENCY RANGE. Ogawa, T.; Tanaka, Y.; Yasuhara, M. (Kyoto Univ.). J. Geomagnet. Geoelec., 19: 377-83(1967).

Most elf noises originate with lightning discharges from thunderstorms over the world. The origin of the Q-type bursts, however, is not clearly understood. A point of interest in attempting to understand the origin of elf noises is the geographical extent of their simultaneous occurrence and the change of waveforms with distance. On May 8, 1966 at 08h 01m 37.6s UT, a large, damped oscillation of about 7.8 Hz was recorded at Kyoto on the vertical electric-field component. After a survey it was found that simultaneous observations were made at Palo Alto, Kauai, and Kerguelen Island. The recorded oscillations are shown and the wave forms are compared. (W.D.M.)

22060 RELATION BETWEEN SUNSPOT NUMBER AND CHARGED PARTICLE DENSITY IN THE UPPER IONOSPHERE. Hirao, Kunio (Tokyo Univ.); Miyazaki, Shigeru. J. Geomagnet. Geoelec., 19: 261-5(1967).

Recently, the profiles of charged-particle density in the topside ionosphere were measured by satellites and rockets including the Japanese sounding rocket Lambda. As charged-particle density is controlled by solar activity, the relation between their quantities is investigated by means of plasma frequency and sunspot number. The result is that this relation may be expressed as the function of plasma temperature and ion composition at 400 km. (auth)

22061 IRREGULAR TYPE SPORADIC-E OBSERVED BY ROCKET BORNE GYRO-PLASMA PROBE AT A TEMPERATURE LATITUDE. Oya, Hiroshi (Kyoto Univ.). J. Geomagnet. Geoelec., 19: 267-72(1967).

By a gyro-plasma probe experiment on board the K-9M-21 rocket, the micro-structure of the electron density profile was measured within an error of ±3%. Irregularity of the electron density fluctuating within ±20% of its average was detected in the altitude ranges of 100 to 103 km and 115 to 120 km independent of the wake effect of the vehicle motion. This irregularity is identified with the radio scattering source of diffuse type sporadic-E on the ionogram obtained during the rocket flight. (auth)

22062 INFLUENCE OF CONTINUOUS SPECTRA OF PARTICLES INJECTED INTO MAGNETOSPHERE ON THE DIMENSIONS AND SHAPE OF THE FORBIDDEN ZONE. Samokhin, M. V. Kosm. Issled., 5: 376-82(May-June 1967). (In Russian).

The distribution of the electric field, created by the separation of the charges during injection of charged particles into the two-dimensional model of the magnetosphere with magnetic fields with the shape m/r^3 (m is constant, r is distance from the axis parallel with the magnetic strong lines) and with a fixed distribution of the electrostatic potential on some profiles of the constant magnetic field, was investigated. It is shown that with neglect of the charge with inertial distribution in the presence of continuous energy spectrum of the injected particles, the forbidden zone has the approximate shape of a circle, the radius of which exceeds the characteristic dimensions of the forbidden Alfven zone by 2 to 3 times. (tr-auth)

22063 GEOMAGNETIC CROCHETS OF SOLAR FLARES OBSERVED IN HURBANOVO. Pinter, S. (Geomagnetic Observatory, Hurbanovo, Czechoslovakia). Bull. Astron. Inst. Czech., 18: 274-81(1967).

The characteristics of geomagnetic crochets and their connection with some parameters of corresponding solar flares were determined on the basis of a detailed analysis of data recorded at the observatory in Hurbanovo ($\phi = 47.9°N$, $\lambda = 18.2°E$). The lag of the maximum ΔH of geomagnetic crochets behind the maximum of flare intensity Δt_{GC} was found to have a mean value of 2.8 minutes. It is shown that the period from the beginning up to maximum T_1 of geomagnetic crochets is smaller than that from the maximum to the end of T_2. The most probable value for T_1 is 4 minutes and for T_2, 13 minutes. The crochets were divided into three groups: sharp crochet, slow crochet, and irregular crochet. The diurnal distribution of the occurrence of crochets has a pronounced maximum at midday. The probability of occurrence has two annual maxima in the period of the equinox and two minima in the period of the solstice. The last 11-year cycle of the occurrence of crochets had two maxima—in 1957 and 1960. It was found that a few more flares associated with crochets occur on the eastern side of the solar disc than on the western side. Altogether, 53.8% of the flares occur on the eastern side of the solar disc. The time dependence of the horizontal component of the geomagnetic field in the period from the maximum to the end of the crochet was used to calculate the recombination coefficient for the lower ionospheric region ($\alpha = 7 \times 10^{-8}$ cm^3 sec^{-1}). (ATD)

22064 SOME REGULARITIES IN THE IONOSPHERIC F1 LAYER. Serafimov, K. Izv. Geofiz. Inst., Bulg. Akad. Nauk, 6: 89-106(1965). (In Bulgarian).

A total solar eclipse analysis indicates that the altitude of maximum electron density concentration in the F1 layer remains constant. An assumption that this constancy is maintained throughout the normal diurnal cycle, serves as a departure point for the following theoretical conclusions. In relation to the given altitude of the atmosphere in the near maximum region of the F1 layer, there occur changes which are in good agreement with the zenith angle of the Sun with the exponent of the corresponding cosinusoidal law approximately equal to 0.2. Consequently, these changes appear to be noninternational with respect to the Sun's altitude. The theoretically expected dependence of critical frequencies f_0F1 on the zenith angle of the Sun is reduced when the changes in the given atmospheric altitude are taken into account. Data obtained at Sofia from the F1 layer observations confirm that the slowly changing p value has its maximum in May and September ($p_{max} = 0.25$) and its minimum in December ($p_{min} = 0.15$). The average value of the monthly indicator agrees with the theoretical estimate namely that $p_z = p_{cp} = 0.20$. At a number of other observation stations it was determined that the indicator p was lower than expected for the normal Chapman α layer. Similarly to the average winter values for the F1 layer, the E layer values were lower than the corresponding summer values. Detailed studies of diurnal and seasonal phenomena, determining the appearance and disappearance of the F1 layer, are described. The present study will serve as a basis for more detailed theoretical and morphological analyses of regularities observed in the ionospheric F1 layer over Bulgaria. (ATD)

22065 CRITERION OF ACCURACY OF THE TOTAL EQUATION FOR THE NONDEVIATIVE ABSORPTION IN THE IONOSPHERIC D REGION. Nestorov, G. Izv. Geofiz. Inst., Bulg. Akad. Nauk, 6: 41-8(1965). (In Bulgarian).

A total equation of the nonderivative absorption in the D region includes two modified components: the equivalent signal frequency and the effective plasma gyrofrequency. For an objective evaluation of the accuracy of the total equation a comparative method of excessive absorption ΔL is proposed, which appears in two or more short wavelengths in the Dellinger effect. In this way the inevitable errors arising in the instruments are eliminated during absolute calibration together with the errors due to instability of the instrumental constants with time. Under these conditions the ΔL value obtained appears to be adequately correct for use as an absorption standard. The proposed comparative method is illustrated with an example. It is shown that the modified equation incorporates all individual cases of propagation and represents an absorption equation of the most general type with satisfactory precision. (ATD)

22066 ION KINETICS IN THE LOWER IONOSPHERE. Mitra, A. P.; Mitra, N. R. (National Physical Lab., New Delhi). J. Inst. Telecommun. Eng., 12: 227-44(1966).

A comprehensive re-examination was made of the ion kinetics of the lower ionosphere in the light of recent space measurements of solar xuv radiation, ion composition and electron density profiles, and laboratory measurements of rate constants. The ionic chemistries of the ions NO^+, O_2^+, N_2^+, and O^+ are discussed. An approach in terms of the individual ionic chemistries and the recognition of NO^+ abundance below 80 km, introduce some fundamental changes in the equations governing lower ionospheric ionization. Laboratory coefficients are found to be generally consistent with the data excepting for the process $N_2^+ + O_2 \rightarrow O_2^+ + N_2$. For the process $O_2^+ + N_2 \rightarrow NO^+ + NO$, for which laboratory observations give only an upper limit, a value of 1×10^{-18} cm^3/s is inferred. A value of 3×10^{-8} cm^3/s is obtained for the dissociative recombination coefficient of NO^+. (auth)

22067 SOME RESULTS OF THE RATE OF ELECTRON PRODUCTION IN COSMIC LAYER OF LOW IONOSPHERE. Velinov, P. (Bulgarian Academy of Sciences, Sofia). Compt. Rend. Acad. Bulg. Sci., 20: 1141-4(1967).

The rate of electron production was calculated at low (30°), average (41°), and high (55°) geomagnetic latitudes. Calculations were made at heights of 50, 60, 70, 80, and 90 km in the D region for winter and summer. (W.D.M.)

22068 GEOMAGNETIC CROCHETS ASSOCIATED WITH PROTON FLARES. Pinter, S. (Geomagnetic Observatory, Hurbanovo, Czechoslovakia). Bull. Astron. Inst. Czech., 18: 282-6(1967).

An attempt is made to find some of the characteristic properties of geomagnetic crochets which are associated with proton flares. Analysis of 29 crochets shows that geomagnetic crochets which are associated with intensive proton flares are also observed at places having a 5- to 6-hour difference compared with the subsolar point. As a consequence, the occurrence of these crochets cannot be explained by a simple increase in the Sq currents and electric current. The value of the lag of the geomagnetic crochet maximum compared with the flare maximum Δt_{GC} was determined. For the crochets investigated, the mean value of Δt_{GC} is 8 minutes. The annual distribution of these "gigantic" crochets shows a maximum occurrence in July and August, i.e., in the summer. The results of investigations of geomagnetic crochets during the last 11-year cycle (1954–65) confirm the existence of two maxima. The first falls on 1957 and the second on 1960. The values of the multiple recombination coefficient and electron density $(\alpha N)_D$ were determined on the basis of the period of decrease in the horizontal component ΔH of the geomagnetic crochets from the maximum of the disturbance on to the normal level. The mean value obtained for the multiple coefficient $(\alpha N)_D$ was 3.8×10^{-4}sec^{-1}. The results confirm the fact that ionizing x radiation, which influences the mechanism of crochets, reaches even the lower D layer. (ATD)

22069 EVIDENCE FOR SOLAR-CYCLE CHANGES IN THE INNER-BELT PROTONS. Nakano, George H. (Lockheed Missile and Space Co., Palo Alto, Calif.); Heckman, Harry H. Phys. Rev. Lett., 20: 806-9(Apr. 8, 1968).

Observations of high-energy protons geomagnetically trapped in the inner Van Allen belt have been carried out since September 1962. Between November 1962 and June 1966, the omnidirectional proton flux at 63 MeV remained constant to within ±7.6%. However, since August 1966 substantial evidence was obtained that the proton flux is decreasing in a manner which is attributable to solar-cycle variations in the density of the upper atmosphere. (auth)

Low-Temperature Physics

Refer also to abstracts 21246, 21255, 21256, 21258, 21353, 21392, 21983, and 22203.

22070 (ORNL-TM-2162) MAGNETIC FLUX FLOW AND SUPERCONDUCTOR STABILIZATION. Quarterly Report, October 1–December 31, 1967. Gauster, W. F.; Efferson, K. R.; Hendricks, J. B.; Kroeger, D. M.; Lubell, M. S. (Oak Ridge Na-

tional Lab., Tenn.). Mar. 1968. Contract W-7405-eng-26. 49p. Dep. CFSTI.

Previously reported work has been continued. Extended observations on the flux flow and stability performance of a bare Nb–25% Ti strip showed that for such samples of low heat capacity the value of power dissipation at takeoff has minor significance. More important is the sample current (or more specifically, I^2R_n) and its relationship to the minimum propagating current. The flux flow and stability performance of compound conductors has been studied under controlled heat transfer conditions. An analysis of a great number of test cases showed that the flux flow and stability performance for samples with highly varying copper to superconductor ratios can be quantitatively predicted in a broad range of external fields. Conclusions can be drawn about the temperature–heat flux characteristics of the liquid-helium-cooled short samples employed for these experiments. Efforts to improve the apparatus for direct measurement of heat transfer from small cylindrical metal surfaces to liquid helium have been continued. Finally, work on "thick" thin films is reported. It includes further developmental work on miniature Hall probes and on vacuum deposition and rf sputtering techniques. These techniques will be used for production of thin films for experimental work on superconductivity and on heat transfer. (auth)

22071 (WASH-1081) SUPERCONDUCTIVITY PROGRAM OF THE ATOMIC ENERGY COMMISSION. Birmingham, B. W. (Atomic Energy Commission, Washington, D. C.). June 1967. 90p. GPO $0.55.

Current activities in the field of superconductivity are discussed, primarily because of programs in high-energy physics and controlled thermonuclear research. The technical and economic benefits to many of the programs are also discussed and suggestions made for future emphasis of the research and development program. It is clear that superconducting dc magnets, using the new high-field materials, offer not only economic gains, but may also make possible experiments that have previously either been technologically impossible or economically not feasible. Superconducting resonant cavities will make continuous operation of linear accelerators possible, and the advancements in cryogenic technology that are sure to result from this application will also make possible the efficient cooling of long coaxial lines for electric signal and power transmission. The application of superconducting devices to synchrotron-type accelerators, storage rings, and accelerator experimental areas needs much more research and study, but the present qualitative understanding of the possible benefits suggests that a substantial effort on these matters would be justified. Finally, the relationship of the AEC laboratories and the industry working on superconducting materials and devices is discussed. It is suggested that a transition phase in superconducting technology is ending and that perhaps there should be a reorientation of the AEC laboratory role to be consistent with public policy. Such a reorientation, involving industry more extensively, should bring about a much more rapid exploitation of superconducting technology along with the associated economic and programmatic benefits. (auth)

22072 PHOTOEFFECT ON NEGATIVE CHARGES IN LIQUID HELIUM. Fomin, I. A. (Inst. of Theoretical Physics, USSR). JETP Lett. (USSR) (Engl. Transl.), 6: 373-6(Dec. 1, 1967).

Translated from Zh. Eksp. Teor. Fiz., Pis'ma Redaktsiyu, 6: 960-3(Dec. 1, 1967).

An explanation is given for the maxima ($\lambda = 1.28\ \mu$) occurring in the plot of the photocurrent against the wavelength of the incident light. (M.O.W.)

22073 STRESS VERSUS RESISTIVITY AT LIQUID HELIUM TEMPERATURE. Brooks, J. M.; Purcell, J. R. (Argonne National Lab., Ill.). Bull. Inst. Int. Froid, Annexe, 521-7(1966).

The effects of stress and magnetic field on the resistivity of copper and high-purity aluminum are shown in a series of curves. Magnetic fields from 0 to 20 kG and stress levels from 0 to 2100 kg/cm^2 were investigated. All tests were conducted at 4.2°K. Each sample was identified by composition and by resistance ratio ($R_{300°K}/R_{4.2°K}$). (auth)

22074 MICRODEGREE TEMPERATURE CONTROLLER FOR LIQUID HELIUM II BATH. Bjarke, G. (Los Alamos Scientific Lab., N. Mex.). Contract W-7405-eng-36. Bull. Inst. Int. Froid, Annexe, 137-41(1966). (LA-DC-7829).

A 1000 Hz resistance bridge system is being developed for resistive temperature transducers in the range of 5000 to 100,000 ohms. Inductive ratio arms are used in a configuration to eliminate effects of capacitance to ground. A narrow band amplifier is used to reduce noise. A synchronous phase sensitive detector provides an output for control or recording. Useful signals are obtained with 5 nanowatts dissipation in the transducer and a sensitivity of 10 ppm. (auth)

22075 TUNNELLING EFFECT AND HIGH PRESSURES. Galkin, A. A.; Svistunov, V. M. (Physico-Technical Inst., Donetsk, USSR). Phys. Status Solidi, 26: K55-7(Mar. 1, 1968).

Electron tunneling techniques were used to measure the energy gap of superconducting lead at 1.3 to 4.2°K in the pressure range up to 14 katm. It was found that the energy gap varies a little faster with pressure than T_c, and at 13.9 katm it is $(4 \pm 0.1)\ kT_c$. This points to a slight reduction of electron–phonon interaction in the pressure range investigated. (A.G.W.)

22076 STRONG PROXIMITY EFFECTS IN Cu: SUPERCONDUCTIVITY OF A FINE Nb–Cu COMPOSITE. Strauss, B. P.; Rose, R. M. (Massachusetts Inst. of Tech., Cambridge). J. Appl. Phys., 39: 1638-44(Feb. 15, 1968).

The magnetic behavior of composites of very fine (less than 1000 Å) niobium wires in copper matrices has been measured at temperatures below 10°K. Three Meissner effects were observed, two of which were apparently due to strong proximity effects in the copper. The temperature dependence of the magnetization curve and measurements of the real and imaginary components of zero-field ac susceptibility agree. The geometry and properties of the composite, which are known in some detail, are used together with current models for proximity effects to develop an adequate explanation of the data. (auth)

22077 EFFECT OF MICROSTRUCTURE ON SUPERCONDUCTING PROPERTIES OF Mo–34 AT. PERCENT Re ALLOY. Witcomb, M. J.; Echarri, A.; Narlikar, A. V.; Dew-Hughes, D. (Univ. of Lancaster, Eng.). J. Mater. Sci., 3: 191-205(Mar. 1968).

The effect of deformation and heat treatments on the magnetisation of superconducting Mo–34 at. % Re alloy was investigated. The microstructure was studied using optical and electron microscopy. The values of the parameter κ of the GLAG theory were determined using three different methods, and they were found to be in accordance with some of the predictions of the Maki theory. The results show that in deformed specimens the magnetic hysteresis is mainly due to the interaction of Abrikosov supercurrent vortices with dislocation tangles; both twin boundaries and grain boundaries are relatively ineffective in causing flux hindrance. The hysteresis observed after annealing is explained in terms of the occurrence of dislocation rearrangement and the precipitation of the sigma phase. Flux-pinning by dislocation tangles is treated as a special case of pinning by normal particles and the magnitude of the resulting pinning force is obtained. The experimental results are compared with the predictions of a theoretical model of flux-pinning. (auth)

22078 SUPERCONDUCTING MAGNET STUDIES. Laverick, Charles (Argonne National Lab., Ill.). pp 189-201 of Les Champs Magnetiques Intenses, leur Production et leurs Applications. Paris, Centre National de la Recherche Scientifique, 1967.

From International Colloquium on Intense Magnetic Fields, their Production and their Applications, Grenoble, France. See CONF-660921.

New forms of composite conductor with and without reinforcing have been designed, fabricated, and tested in coils and the results are reported. Experiments with heavier-section wire-type conductors are described and indicate that cheaper and simpler magnets can be anticipated. Some studies in the medium-size magnet range, of the order of 30-cm bore are described and their implications discussed. Cooling techniques have been investigated at temperatures other than 4.2°K, and some available results are mentioned. The effect of radiation on operating coils has been studied in the secondary beam from the Argonne National Laboratory 60-inch cyclotron and attempts have been made to assess the effect of large radiation doses on coils immersed in liquid helium in the Argonne National Laboratory CP-5 reactor. (auth)

22079 FABRICATION PROCESS FOR AND PROPERTIES OF A FLEXIBLE Nb_3Sn CONDUCTOR. Smulkowski, O. (CSF, Puteaux, France). pp 215-21 of Les Champs Magnetiques Intenses, leur Production et leurs Applications. Paris, Centre National de la Recherche Scientifique, 1967. (In French).

From International Colloquium on Intense Magnetic Fields, their Production and their Applications, Grenoble, France. See CONF-660921.

A process for the fabrication of great lengths of Nb_3Sn conductor is described. This process utilizes the diffusion of tin in niobium which is used in the shape of thin ribbon and concurrently plays the part of core and starting element. The conductor thus achieved is flexible and can be wound after all heat treatments on minimum radius of 5 mm in the shape of disk type coils. Connections between different lengths are made by classical tin–lead soldering alloy. The resistivity of such a junction is about $10^{-8}\ \Omega$ per square

centimeter of overlap. Minimum critical current in a field of 100 kG is 100 A per centimeter of width of a ribbon 30 μ thick. Maximal magnetic field reached with this conductor is now 126 kG. (auth)

22080 PROPERTIES OF HIGH-FIELD SUPERCONDUCTORS IN MAGNETIC FIELDS UP TO 230 KOe. Saur, Eugen (Univ., Giessen, Ger.); Wizgall, Hermann. pp 223-30 of Les Champs Magnetiques Intenses, leur Production et leurs Applications. Paris, Centre National de la Recherche Scientifique, 1967.

From International Colloquium on Intense Magnetic Fields, their Production and their Applications, Grenoble, France. See CONF-660921.

The critical field curves of Nb_3Sn, V_3Si, V_3Ga and NbN have been measured. By extrapolation from these curves the following zero critical fields have been found: 245 kOe for Nb_3Sn, 235 kOe for V_3Si, 210 kOe for V_3Ga and 153 kOe for NbN. The quenching behavior of different types of bulk samples of these compounds in transverse magnetic fields, partially up to 230 kOe, has been investigated. The quenching curves of some V_3Ga samples and of nearly all NbN samples show very pronounced "peak effects" in the high field region. Specially prepared Nb_3Sn samples with filamentary structure ("multiwires") are still superconducting with high critical currents beyond 230 kOe. (auth)

22081 STABILITY CRITERIA FOR CURRENT IN COMBINED (NORMAL + SUPERCONDUCTING) CONDUCTORS. Keilin, V. E.; Klimenko, E. Yu.; Kremlev, M. G.; Samoilov, B. N. (Kurchatov Inst. of Atomic Energy, Moscow). pp 231-6 of Les Champs Magnetiques Intenses, leur Production et leurs Applications. Paris, Centre National de la Recherche Scientifique, 1967.

From International Colloquium on Intense Magnetic Fields, their Production and their Applications, Grenoble, France. See CONF-660921.

The conditions have been obtained, necessary for stabilization of a current in a conductor consisting of normal and superconducting wires which are in intimate thermal and electrical contact. (M.O.W.)

22082 EXPERIMENT ON A SEMISTABILIZED SUPERCONDUCTING CABLE. Desportes, Henri (CEN, Saclay, France). pp 275-80 of Les Champs Magnetiques Intenses, leur Production et leurs Applications. Paris, Centre National de la Recherche Scientifique, 1967. (In French).

From International Colloquium on Intense Magnetic Fields, their Production and their Applications, Grenoble, France. See CONF-660921.

The performances of a semi-stabilized superconducting cable made of 6 strands of Nb–Zr and 13 strands of copper have been investigated on a series of coils in order to find out the optimum winding conditions and the stability level of this type of cable. These tests have shown the advantage of the heat treatment of the superconducting material and the need for an adequate insulation of the winding. Coils made with the proposed type of insulation have exhibited critical currents of 300 to 360 A at fields over 40 kG, with stored magnetic energies in the range of 40 kJ and average current densities of about 8000 A/cm^2. A detailed investigation of the quenching phenomenon has enabled the intrinsic safety level of such coils to be estimated. (auth)

22083 DEVELOPMENT OF Nb–Ti SUPERCONDUCTING COILS FOR PRODUCING MAGNETIC FIELDS ABOVE 80 kOe. Donadieu, L.; Roubeau, P. (CEN, Saclay, France). pp 303-10 of Les Champs Magnetiques Intenses, leur Production et leurs Applications. Paris, Centre National de la Recherche Scientifique, 1967. (In French).

From International Colloquium on Intense Magnetic Fields, their Production and their Applications, Grenoble, France. See CONF-660921.

The critical characteristic curves current–field (I–H) of several alloys of Nb–Ti have been investigated up to field higher than 80 kOe for materials with several compositions which are used as wire of variable diameter or multistranded cables. The stable characteristic curves (zero propagation velocity) have been measured for cables diversely stabilized. Several Nb–Ti superconducting coils which produce field up to 92 kOe have been made and tested in Marcoussis. The results of the investigation are discussed. In particular, a coil made of a multistranded cable which generates a field of 79 kOe in a 50-mm-diameter bore is described. (auth)

22084 MEASUREMENTS OF THE RESISTIVE TRANSITION OF Nb_3Sn RIBBON IN PULSED MAGNETIC FIELDS UP TO 330 kOe. van der Sluijs, J. C. A.; de Beun, H. R.; Zweers, B. A.; de Klerk, D. (Kamerlingh Onnes Lab., Leiden). pp 429-37 of Les Champs Magnetiques Intenses, leur Production et leurs Applications. Paris, Centre National de la Recherche Scientifique, 1967.

From International Colloquium on Intense Magnetic Fields, their Production and their Applications, Grenoble, France. See CONF-660921.

Measurements were made of the resistive transition of Nb_3Sn ribbon, fabricated by Supercon, in pulsed magnetic fields. The results differ in a number of aspects from the results obtained on wire materials and on ribbon materials in steady fields. For comparison, some experiments were repeated on RCA-type ribbon and on Nb–25% Zr wire. A short description of the pulsed field apparatus is presented. (auth)

22085 SUPERCONDUCTING COIL. Iwamoto, Masatami; Sato, Takashi (Mitsubishi Electric Corp., Tokyo). Mitsubishi Denki Lab. Rep., 41: 1480-5(Dec. 1967). (In Japanese).

Superconducting coils, epochal magnetic field generating devices, have gone through two distinctive stages. The first one is a period in which extensive search was made to embody the theory into practical use and difficulties were faced. In the second one painstaking efforts by scientists began to bear fruit and a number of superconducting coils were developed one after another. On the part of Mitsubishi, a superconducting coil No. 1 rated at 60 kG was built by the company. The features and characteristics of the superconducting coils are described together with the process of study and also examples of trial products. (NSA of Japan)

22086 PHENOMENA RESULTING FROM THE HEATING OF SMALL WIRES IN He II. Vinson, James S.; Agee, Forrest J. Jr.; Manning, Robert J.; Hereford, Frank L. (Univ. of Virginia, Charlottesville). Phys. Rev., 168: 180-2(Apr. 5, 1968).

In a previous experiment the scintillation of He II was found to be enhanced at certain critical values of heat flux introduced into the fluid by a small heated wire. The results presented here demonstrate that this phenomenon is related to the formation of some form of visible turbulence or, alternatively, of a vapor bubble around the wire, depending on the depth of the wire in the He II bath. Results are presented also on the dependence of the critical heat current on wire depth and on temperature. (auth)

22087 DISCRETE FLOW RATES OF THE HELIUM FILM. Turkington, R. R.; Edwards, M. H. (Royal Military Coll., Kingston, Ontario). Phys. Rev., 168: 160-2(Apr. 5, 1968).

Measurements of the helium-film flow rates over a stainless steel substrate have been made using the heat-transport method of Bowers, Brewer, and Mendelssohn. The moving film from a reservoir is vaporized inside a copper box at the top of the stainless steel capillary in a closed system, by electrical heating. The vapor recondenses in the isothermal reservoir. On any day's run, the rate was constant and reproducible to within 1%. The complete range of flow rates observed at 1.2°K on separate days was about 50%. Seven discrete rates were in fact observed in 18 runs nearly equally spaced at intervals of 0.83×10^{-5} cm^2 sec^{-1}. At present, no theory predicts discrete flow rates. (auth)

22088 DISTRIBUTION OF VORTICES IN ROTATING HELIUM II. Stauffer, Dietrich (Max-Planck-Institut fuer Physik und Astrophysik, Munich); Fetter, Alexander L. Phys. Rev., 168: 156-9(Apr. 5, 1968).

The distribution of vortices in a rotating cylinder or annulus filled with helium II is studied by two distinct methods. In the continuum approximation, a vortex-free strip of width $\approx 1.4n^{-\frac{1}{2}}$ occurs near each wall, where n is the vortex density. Exact computer calculations show that the vortices in a cylinder tend to form concentric circles about the origin. Only some of these patterns display triangular symmetry. In consequence, any experiment relying on the spatial periodicity of the vortex array is unlikely to give consistent results. (auth)

22089 EXPERIMENTAL ION MOBILITIES IN LIQUID ^3He BELOW 1°K. Anderson, A. C.; Kuchnir, M.; Wheatley, J. C. (Univ. of Illinois, Urbana). Contract AT(11-1)-1198. Phys. Rev., 168: 261-70(Apr. 5, 1968). (COO-1198-492).

The low-field mobility of positive and negative ions in liquid ^3He was measured using a time-of-flight technique for temperatures between 0.03 and 1°K and pressures of 27.9, 7.5, and less than 0.35 atm. Details of the experimental procedures as well as of the experimental apparatus and its construction are presented. The positive-ion mobility μ_+ was found to be larger than the negative μ_-, except at 27.9 atm above 0.3°K, where both are ~0.036 cm^2/V sec. By increasing the pressure, μ_- was observed while μ_- decreased. Furthermore, μ_- was found to be a continuous function of the temperature, reproducible within 1% throughout the entire temperature range of the measurements, whereas μ_+ presented hysteresis in a temperature range that was dependent on the pressure. Some typical mobility values are tabulated. The systematic error involved in the absolute value of the mobility is less than 10%. No theoretical calculation presently available correctly predicts μ_- or μ_+. (auth)

22090 STUDY OF THE ION–VORTEX-RING TRANSITION. Rayfield, G. W. (Univ. of Oregon, Eugene). Phys. Rev., 168: 222-33(Apr. 5, 1968).

The velocity of bare ions and vortex rings in the region of the ion–vortex-ring transition as a function of applied electric field was experimentally studied and is described in detail. The velocity at which a bare ion produces quantized vortex rings has been determined. In the case of negative ions under pressure, this critical velocity is related to the radius of the negative-ion bubble. It was also found that creation of vortex rings by bare ions requires a considerably larger electric field than that necessary to support a singly charged vortex ring. An effect associated with the radioactive source (for producing ions) was observed, which allowed vortex rings to be produced in the source region with comparatively weak electric fields. Vortex rings having a radius as small as 37 Å were studied, and no deviation from the classical hydrodynamic equation was observed. The data indicate that the vortex core size may be pressure- and temperature-sensitive. (auth)

22091 THEORY OF VORTEX RESONANCE IN LIQUID HELIUM. Halley, J. Woods; Cheung, A. (Univ. of California, Berkeley). Phys. Rev., 168: 209-21(Apr. 5, 1968).

A theory is developed, which predicts the behavior of a positive ion on a linear vortex in the presence of a dc electric field along the vortex and an ac electric field normal to the vortex. It is shown that with an appropriate (and accessible) combination of experimental parameters, it should be possible to observe resonances in the ion's velocity along the vortex as a function of dc field and ac frequency. These resonances would arise from the excitation of vortex oscillations and could be utilized to determine experimentally vortex oscillation dispersion relation for small k. An experimental verification of the Kelvin result $\omega_k = (-\hbar k^2/2m)(\ln ka - 0.116)$ should thus be possible. (auth)

22092 MAGNETOSTRICTION IN TYPE-II SUPERCONDUCTORS. Brandli, G. (Swiss Federal Inst. of Tech., Zurich); Enck, F. D. Phys. Lett., 26A: 360-1(Mar. 11, 1968).

The magnetostriction and magnetization were measured simultaneously in a type II superconducting InPb alloy. From the measured curves, H_c, H_{c2}, κ, and their dependences on uniaxial pressure, $p_{||}$, parallel to the magnetic field were calculated. $\partial \ln\kappa/\partial p_{||} = 5.5 \pm 2 \times 10^{-12}$ cm²/dyn is found for In-9 at. % Pb. (auth)

22093 FLUCTUATIONS IN A JOSEPHSON JUNCTION. Fetter, Alexander L. (Stanford Univ., Calif.); Stephen, Michael J. Phys. Rev., 168: 475-80(Apr. 10, 1968).

The classical-field description of a long Josephson junction is reinterpreted as a quantum-field theory, which allows a unified treatment of fluctuation phenomena in both the Meissner state and the mixed state. For practical configurations, the mean square fluctuations in the field φ are negligible, and the zero-point corrections to the energy in the mixed state are less than 1%. (auth)

22094 SPATIAL VARIATIONS OF THE ORDER PARAMETER IN SUPERCONDUCTORS CONTAINING MAGNETIC IMPURITIES. Heinrichs, Jean (Univ. of California, San Diego, La Jolla). Phys. Rev., 168: 451-63(Apr. 10, 1968).

The problem of spatial variations of the order parameter in the vicinity of a paramagnetic impurity and near the transition temperature is reconsidered by means of a more rigorous formalism than in a discussion that appeared recently in the literature. General expressions are derived for the spatially inhomogeneous part of the order parameter and its effect on the critical temperature in the limit of very small concentrations of impurities. A detailed analysis shows that the dominant variations of the order-parameter range to a distance of the order of the coherence length $\xi_0 \simeq v_F/2\pi T_{c0}$ from a single impurity, but that this parameter also exhibits weak long-range variations in the region $r \gg \xi_0$. For $r < \xi_0$, both smooth spatial variations and fast oscillations show up in the expression of the superconducting order parameter. In the Born approximation the result for the transition temperature coincides with that of the Abrikosov–Gor'kov theory, where the average value of the order parameter is used. The next higher-order correction, due to spatial variations, leads to a small increase of the transition temperature, which is explicitly estimated. (auth)

22095 SUPERCONDUCTIVITY IN GRANULAR ALUMINUM FILMS. Cohen, Roger W.; Abeles, B. (RCA Labs., Princeton, N. J.). Phys. Rev., 168: 444-50(Apr. 10, 1968).

A detailed description is given of the preparation of granular aluminum films (grain sizes less than 40 Å) with stable superconducting transition temperatures T_c up to 3.7°K. New experimental data of energy gaps, parallel critical fields, and critical current densities are presented. The results are in good agreement with the predictions of the theories of granular superconductors. However, it is found that none of the mechanisms offered so far for the enhancement of T_c can satisfactorily account for all the properties of the enhanced T_c granular films. (auth)

22096 SUPERCONDUCTING PROXIMITY EFFECT OF Nb. Kircher, C. J. (IBM Research Center, Yorktown Heights, N. Y.). Phys. Rev., 168: 437-41(Apr. 10, 1968).

Previous investigators have studied the proximity effect of a number of nontransition-metal superconductors. In this investigation the proximity effect of Nb (a transition-metal superconductor) has been studied using the Nb–Cu and Nb–Ni systems. The films were sputtered sequentially without breaking vacuum. The sandwiches were maintained at temperatures below 200°K until after T_c had been measured, to preclude chemical or metallurgical interactions. Sandwich T_c has been obtained as a function of Nb film thickness for thick overlayer films. The Nb–Cu data are in agreement with the de Gennes–Werthamer theory. The Nb–Ni data follow the form of the adjustable-parameter ($\beta \equiv \hbar/2\pi k_B T_c$) theory proposed by Werthamer. However, Ni is found to have less effect on Nb than was reported for Pb: a value of $\beta = 7$ is obtained for Nb compared to $\beta = 43$ for Pb. Possible explanations of the observed behavior are discussed. (auth)

22097 ORIENTATIONAL DEPENDENCE OF THE FLUX-FLOW RESISTIVITY AND CRITICAL CURRENT DENSITY IN TYPE-II SUPERCONDUCTING FOILS. Joiner, W. C. H.; Kuhl, G. E. (Univ. of Cincinnati). Phys. Rev., 168: 413-17(Apr. 10, 1968).

Flux-flow measurements on type-II superconducting foils show that the Lorentz force is fully adequate to describe the angular dependence of the flux-flow resistivity. The orientational dependence of the critical-current density is not simply obtained, however, by assuming that flow begins when the Lorentz force achieves a critical value. Instead, the results imply an anisotropy in the pinning force, which is interpreted in terms of the natural anisotropy of the surface in a foil sample. The role of the surface in flux pinning is therefore emphasized again. (auth)

22098 SUPERCONDUCTIVITY IN THE LANTHANUM SELENIDE SYSTEM. Holtzberg, F.; Seiden, P. E.; von Molnar, S. (IBM Watson Research Center, Yorktown Heights, N. Y.). Phys. Rev., 168: 408-12(Apr. 10, 1968).

Lanthanum selenide has been found to be a very good system in which to investigate the dependence of superconductivity on various material parameters, since in this system one can vary these parameters in a relatively independent manner. This investigation reports on the behavior of the superconducting transition temperature as a function of electron concentration and on measurements of some relevant electronic and lattice properties of the system. Crystallographic, Hall-effect, Pauli-susceptibility, and specific-heat measurements were made and found to be in accord with a model of lanthanum selenide as a free-electron-like metal. Using this model, the electron-concentration dependence of the transition temperature was calculated and found to be in excellent agreement with experiment over the whole experimentally measured range of 1 to 10°K, corresponding to a variation of electron concentration between 0.8 and 5.4×10^{21} electrons/cc. (auth)

22099 CALCULATION OF THE SUPERCONDUCTING TRANSITION TEMPERATURE. Seiden, P. E. (IBM Watson Research Center, Yorktown Heights, N. Y.). Phys. Rev., 168: 403-8(Apr. 10, 1968).

An explicit expression is derived for the superconducting transition temperature in an isotropic superconductor. The calculation includes three improvements over previous work. Firstly, strong-coupling effects are included; secondly, both normal and umklapp contributions are evaluated in detail in calculating the electron–phonon interaction; and thirdly, a more realistic approximation to the lattice is obtained by including a Coulomb pseudopotential and correcting the jellium ionic plasma frequency with the use of the measured sound velocity. The theory is applied to the case of the lanthanum selenide system, in which one can vary the electron concentration independently of other material parameters and measure the superconducting transition temperature as a function of this variation. The theory accounts very well for the observed transition temperatures over the whole measured range from 1 to 10°K. (auth)

22100 SUPERHEATING OF THE MEISSNER STATE AND THE GIANT VORTEX STATE OF A CYLINDER OF FINITE EXTENT. Fink, H. J.; Presson, A. G. (Atomics International, Canoga Park, Calif.). Phys. Rev., 168: 399-402(Apr. 10, 1968).

The superheating field and the size-dependent critical field of the Meissner state for a cylinder of radius R, with Ginzburg–Landau (GL) parameters κ between 0.3 and 2.4 and size parameters R/λ between 2.5 and 20, have been calculated from the GL theory. For very large values of R/λ the superheating field of the

cylinder approaches that of the semi-infinite half-space. Similar studies of the giant vortex state show that the superheating fields are smaller than for the Meissner state. Under certain conditions, as the applied magnetic field is increased, the solutions to the GL equations may cease to exist for the Meissner and giant vortex state for a constant value of the fluxoid quantum number before the Gibbs free energy of the superconducting state reaches that of the normal state. (auth)

22101 MAGNETIC IMPURITIES AND SUPERCONDUCTIVITY BELOW THE KONDO TEMPERATURE: NAGAOKA'S MODEL. Zuckermann, M. J. (McGill Univ., Montreal. Imperial Coll. of Science and Tech., London). Phys. Rev., 168: 390-8(Apr. 10, 1968).

The Green's-function method and decoupling scheme due to Nagaoka for dilute magnetic alloys in the normal state is extended to include superconductivity. A general expression for the superconducting critical temperature T_c is found for low-impurity concentrations n_I. This expression involves unknown parameters that occur in Nagaoka's equations for the normal state. When $T_c \gg$ Kondo temperature T_K, the expression for the initial change in T_c with respect to n_I contains two terms: (i) the decrease in T_c of Abrikosov and Gor'kov as corrected by Maki and Griffin for the Kondo anomaly, and (ii) a change in T_c due to the polarization of the impurity spin, which depends on the sign of the coupling constant J of the s–d exchange interaction. To order J^3, the term (ii) corresponds to the Solyom and Zawadowski's result. These results are obtained by use of Nagaoka's solution of his equations in the range $T_c \gg T_K$. A solution of Nagaoka's equations due to Hamann is next used to find an expression for T_c valid for all T_K. This expression is analyzed and compared with experimental data in the range $T_c \ll T_K$. (auth)

22102 MELTING CURVE OF ^{3}He. Thompson, J. R.; Meyer, H. Cryogenics, 7: 296-7(Oct. 1967).

A calculation of the melting curve of helium-3 at temperatures below 0.04°K was made. This is an extension of the work of Anderson et al. [Phys. Rev., 130: 1644(1963)] using the new specific heat data of Abel et al. [Phys. Rev., 147: 111(1966)] and taking into account the spin exchange interaction in the solid as determined from nuclear magnetic resonance relaxation data. (UK)

22103 VAPOUR PRESSURE OF ^{3}He IN HIGH MAGNETIC FIELDS. Kopp, J. (Oxford Univ.). Cryogenics, 7: 271-3(Oct. 1967).

A magnetic field is shown to depress the vapor pressure of helium–3. A simple calculation, starting from the vapor pressure equation and considering the nuclear spin entropies in detail, leads to an effect proportional to (H/T), which should be detectable at 100 kOe. The influence of the field gradient is shown to be negligible. (auth) (UK)

22104 FLUX LINKAGE AND SELF-INDUCTANCE OF SUPERCONDUCTING SOLENOIDS. Sytchev, V. V.; Andrianov, V. V.; Zenkevich, V. B.; Ternovskii, F. F. (Research Inst. for High Temperatures, Moscow). Cryogenics, 7: 344-50(Dec. 1967).

The magnetic behavior of a superconducting coil for the case of self-excitation is considered. The treatment makes use of the concepts of flux linkage and the coefficient of self-inductance of a superconducting coil. The total magnetic flux linked with superconducting windings is considered to be composed of two fluxes. The externally linked flux is directly proportional to the current flowing in the solenoid. The internally linked flux determines the magnetic behavior of superconducting windings and remains constant in all physical situations where the distribution of magnetic inductance in the bulk of superconducting material does not vary. Measurements of internally linked flux have resulted in producing a fairly complete picture of the magnetic behavior of a superconducting solenoid. Use of the familiar law of induction distribution in the bulk of superconducting material has made it possible to give a theoretical account of current dependence of internally linked flux. Consideration is also given to dependence of the self-inductance coefficient of a superconducting coil on the energizing current, and the effect of flux jumps on the inductance value. (auth)

22105 ENHANCEMENT OF THE CRITICAL TEMPERATURE OF ALUMINUM BY MOLECULAR INCLUSIONS. Gamble, F. R.; McConnell, H. M. (Stauffer Lab. for Physical Chemistry, Stanford, Calif.). Phys. Lett., 26A: 162-3(Jan. 15, 1968).

Critical temperatures as high as 5.24° have been observed in Al films containing organic molecules. Simultaneous condensation of Al and tetracyanoquinodimethan produces a material with this high critical temperature. (M.H.R.)

22106 ANOMALOUS SUPERCONDUCTING NUCLEATION FIELDS. Wraight, P. C. (Cambridge Univ., Eng.). Phys. Lett., 26A: 140-1(Jan. 15, 1968).

An alternative explanation is put forward of the anomalous ratios of H_{c3} to H_{c2} found in certain indium–thallium alloys, and further experiments are proposed. (auth)

22107 FLUX JUMPS IN TYPE II SUPERCONDUCTORS. Wertheimer, M. R.; Gilchrist, J. le G. (Centre de Recherches sur les Tres Basses Temperatures, Grenoble, France). J. Phys. Chem. Solids, 28: 2509-24(Dec. 1967).

The Faraday rotation technique was used in the study of flux jumps in pure and alloy specimens in the form of discs, which were placed perpendicularly in an applied magnetic field. Numerous qualitative aspects of flux jumping are discussed in the light of earlier experimental results. Alternate use of a FASTAX high-speed ciné camera and an electronic detecting device permitted measurement of the speed of flux jumps. The speed increases with decreasing specimen thickness, and increasing normal-state resistivity. This behaviour is explained quite well in terms of speed limitation by eddy currents; this explanation also gives the correct magnitude. The conditions for the start of a jump are also discussed in terms of a simple model. (auth) (UK)

22108 ULTRASONIC ATTENUATION IN SUPERCONDUCTING NIOBIUM. Tsuda, Nobuo; Suzuki, Taira (Tokyo Univ.). J. Phys. Chem. Solids, 28: 2487-97(Dec. 1967).

A study of ultrasonic attenuation using longitudinal waves of 30 M was carried out for superconducting niobium, whose resistance ratio varied from 100 to 830. The measured temperature dependence of the relative attenuation α_s/α_n was found to deviate from the BCS relation with increasing purity, when $ql < 1$. A similar deviation was also found for the magnetic field dependence of α_s/α_n. The results cannot be explained by an anisotropic or a two-gap model. (auth) (UK)

22109 FLUX JUMPS IN HARD SUPERCONDUCTORS. Morton, N. (Univ. of Salford, Eng.). Cryogenics, 7: 341-3(Dec. 1967).

Flux jumps in hard superconductors have been attributed by previous authors to spatial temperature variations arising during the magnetization process. The present author calculated the temperature rise as a function of radius and field during the initial magnetization of a cylinder of hard superconductor. Significant temperature gradients were found to appear and these are assumed to precipitate the flux jumps. (auth) (UK)

22110 CRYOGENIC VALVE DESIGN CONSIDERATIONS. Fair, Robert L.; Barnes, C. B. (CVI Corp., Columbus, Ohio). Annu. ISA (Instrum. Soc. Amer.) Conf. Proc., 22: 34.2.CHEMPID.67.1-6(1967).

From 22nd Instrument-Automation Conference and Exhibit, Chicago. See CONF-670903-(Pt.4).

The application of basic principles to the design of a vacuum jacketed cryogenic globe valve is discussed. A design has been produced which provides a low cooldown mass, tight sealing, low heat leak and high flow valve for cryogenic service. Their use over an extended period of time has proven them to be rugged and reliable. Tabulated test results on heat leak and flow characteristics for a three-quarter-inch vacuum-jacketed valve are included. (auth)

22111 PROPERTIES OF ^{3}He NEAR THE CRITICAL POINT. Bendiner, W.; Elwell, D.; Meyer, H. (Duke Univ., Durham, N. C.). Phys. Lett., 26A: 421-2(Mar. 23, 1968).

The critical properties of ^{3}He and the indices β, γ, and δp for the power laws have been determined from isobaric density measurements above and below the critical point. (auth)

22112 LOW-TEMPERATURE TRANSITION OF A TWO-DIMENSIONAL BOSE SYSTEM. Reatto, L. (Univ., Milan. Consiglio Nazionale delle Ricerche, Milan). Phys. Lett., 26A: 400-1(Mar. 23, 1968).

It is shown that a two-dimensional Bose system has a low-temperature transition to a state with infinite "susceptibility." An experiment is proposed to clarify the nature of the superfluid transition of thin films of ^{4}He. (auth)

22113 TEMPERATURE DEPENDENCE OF THE MAGNETIC FIELD PERIODICITY IN FLUX QUANTIZATION EXPERIMENTS. Meservey, R. (Masachusetts Inst. of Tech., Cambridge); Meyers, L. Phys. Lett., 26A: 367-8(Mar. 11, 1968).

An unexpected temperature dependence of the magnetic field periodicity has been observed in flux quantization experiments on superconducting thin-film hollow cylinders of aluminum. Alternate explanations are offered in terms of variations in the thickness or in the order parameter. (auth)

22114 λ-POINT SHIFT IN TURBULENTLY FLOWING ^{4}He. Erben, K. D.; Pobell, F. (Technische Hochschule, Munich). Phys. Lett., 26A: 368-9(Mar. 11, 1968).

Shifts of the λ temperature of ^{4}He up to $\Delta T_\lambda = 1.4 \times 10^{-3}$°K due to turbulent flow caused by a heat current in a wide tube have been observed. (auth)

22115 ABSORPTION OF ULTRASOUND IN SUPERCONDUCTIVE ALUMINIUM. Fil, V. D.; Shevchenko, O. A.; Bezuglyi, P. A. (Physical-Technical Inst. of Low Temperatures, Kharkov). Z. Eksp. Teor. Fiz., 54: 413-18(Feb. 1968). (In Russian).

The absorption of the longitudinal ultrasound of 175 to 225 M in monocrystalline superconductive aluminium is investigated for different propagation directions. A possibility is discussed for determining the minimum gap from ultrasound data. It is shown that the results of ultrasound measurements can be brought in agreement with the results of other papers only by assuming a "strong" anisotropy of the energy gap. (auth)

22116 EXTENSION OF THE EQUATIONS OF THE GINZBURG–LANDAU THEORY FOR NONSTATIONARY PROBLEMS TO THE CASE OF ALLOYS WITH PARAMAGNETIC IMPURITIES. Gor'kov, L. P.; Eliashberg, G. M. (Inst. of Theoretical Physics, Moscow). Z. Eksp. Teor. Fiz., 54: 612-26(Feb. 1968). (In Russian).

A simple diagram method is developed which permits one to analyze nonlinear nonstationary problems of superconductivity theory by directly using physical quantities which depend on real "physical" time. In the case of alloys with paramagnetic impurities the method yields a nonstationary generalization of the Ginzburg–Landau equations which is valid for all significant frequencies. Some nonlinear problems are solved on basis of the equations derived. (auth)

22117 STUDY OF SUPERCONDUCTIVITY IN INTERSTITIAL COMPOUNDS. Pessall, N.; Gold, R. E.; Johansen, H. A. (Westinghouse Research Labs., Pittsburgh). J. Phys. Chem. Solids, 29: 19-38(Jan. 1968).

A large number of interstitial compounds with the NaCl crystal structure were prepared with particular emphasis on pseudo-binary alloys based on niobium nitride and vanadium nitride in combination with other nitrides and carbides. In addition, several pseudo-ternary systems and a pseudo-quaternary system based on niobium carbonitride were investigated. The results of x-ray and chemical analyses, and measurements of critical temperature T_c, are presented. It is concluded that values of $T_c > 18$°K should be attainable in the pseudo-ternary system NbN–NbC–TiN. Several empirical correlations between transition temperatures and other simple physical quantities were evaluated in terms of the new experimental data and shown to be only partially successful in systematizing interstitial compounds. The T_c–electron density correlation is shown, however, to be the most successful empirical method systematizing both β–W and NaCl structure compounds. (auth)

Plasma and Thermonuclear Physics

22118 (AED-C-03-16) PLASMA PHYSICS INDEX. EXPERIMENTAL AND THEORETICAL PLASMA PHYSICS. Bibliography; Author Index; Subject Index. Volume 3, No. 1. Hilsenbeck, D. (comp.) (Zentralstelle fuer Atomkernenergie-Dokumentation, Frankfurt am Main (West Germany)). 1968. 80p. Dep.

A listing of 432 papers on various aspects of plasma physics is presented. Subject and author indexes are included. (M.O.W.)

22119 (TID-24331) QUARTERLY PROGRESS REPORT NO. 88. Zimmermann, H. J.; Harvey, G. G.; Mason, S. J. (Massachusetts Inst. of Tech., Cambridge. Research Lab. of Electronics). Jan. 15, 1968. 372p. Dep. CFSTI.

Separate abstracts were prepared for 6 of the included sections. (M.O.W.)

For abstracts of individual sections see: 21847, 22137, 22138, and 22147–22149.

Confinement and Heating of Plasma

22120 (UCID-15241(Rev.1)) PRELIMINARY INVESTIGATION OF THE PROPERTIES OF A SCALED-UP ASTRON. Christofilos, N. C. (California Univ., Livermore. Lawrence Radiation Lab.). Oct. 30, 1967, Revised Nov. 16, 1967. Contract W-7405-eng-48. 23p. Dep. CFSTI.

The problems considered in the scaled-up Astron are: (1) magnetic field pattern of a thick E-layer and Bohm confinement time in this pattern, and (2) plasma scaling laws; selection of the momentum of the E-layer particles; calculations of the tolerable confinement time in comparison to Bohm confinement time. (M.O.W.)

22121 (UCID-15282) PLASMA CONFINEMENT WITHIN RELATIVISTIC PROTON COILS DISPOSED IN A TOROIDAL CONFIGURATION. Christofilos, N. C. (California Univ., Livermore. Lawrence Radiation Lab.). Dec. 5, 1967. Contract W-7405-eng-48. 18p. Dep. CFSTI.

In the solution of the vector potential of the E layer and the external magnetic field the slight tilt between the axis of adjacent E layers is neglected and the problem is solved in the approximation of an infinite sequence of E layers one placed adjacent to the other along the z direction. (M.O.W.)

22122 (UCID-15294) FIRST EXPERIMENTS WITH THE IMPROVED ASTRON FACILITY. Christofilos, N. C. (California Univ., Livermore. Lawrence Radiation Lab.). Feb. 29, 1968. Contract W-7405-eng-48. 16p. Dep. CFSTI.

The observations in these experiments were limited in measurements of E-layer lifetime and observations of the precession phenomena as a function of the loading factor of the E-layer. (M.O.W.)

22123 HIGH MAGNETIC FIELDS AND THEIR APPLICATION IN PLASMA PHYSICS. Oswald, Bernhard (Inst. fuer Plasmaphysik, GmbH, Garching, Ger.). Elektrotech, Z., A., 86: No. 2, 40-7(Jan. 22, 1965). (In German).

A review is given of high-field generation techniques. These include the use of water-cooled and superconducting coils and the use of impulse coils fed by capacitive or mechanical storage devices. (TSS)

22124 OHMIC HEATING OF DENSE HYDROGEN PLASMA. Alikhanov, S. G.; Boyarintsev, E. L.; Konkashbaev, I. K.; Kornilov, V. A. Zh. Prikl. Mekh. Tekh. Fiz., No. 4, 121-5(July-Aug. 1967). (In Russian).

The authors investigated the possibility of ohmic heating of a hydrogen plasma in a quasi-stationary discharge without an external magnetic field (discharge time 180 μsec, maximum current 160 kA) A stable plasma column free of impurities was obtained, with the temperature close to 10 eV and a density 2×10^{18} cm^{-3}. The discharge was produced in a ceramic chamber (inside diameter 5 cm, height 15 cm) pressed inside a steel cylinder which served as the current return lead. The plasma parameters were investigated with a high-speed camera to photograph the discharge, a time sweep of the emission spectrum, and measurements of the gas kinetic pressure, the longitudinal electric field, and the magnetic field components. Prior to application of the main discharge, a preliminary plasma was produced with the aid of a fast pulsed discharge (100 kA). The results indicate that at the current maximum the gas kinetic pressure is not fully balanced by the magnetic field, and that part of the pressure is maintained by the chamber walls. A numerical calculation of the heating process, based on the energy balance, is in good agreement with the experimental results, provided the density in the current channel is on the order of 2×10^{18} cm^{-3}. (ATD)

22125 CALCULATIONS OF ELECTRIC ARC GAS HEATING PROPERTIES. Suksov, I. I. Zh. Prikl. Mekh. Tekh. Fiz., No. 4, 132-6(July-Aug. 1967). (In Russian).

A mathematical analysis was made of an electric arc heater in a round tube in the case in which local enthalpy and specific gas consumption are not functions of longitudinal coordinates (i.e., in the case of stabilized electric arc heating). Numerical formulas for determining the enthalpy and electric characteristics were obtained by random approximations, and relations for determining gasdynamic characteristics were found. Data obtained for air pressure (1 to 100) $\times$ 1.01325 $\times 10^5$ n/m^2 at axial column temperature of 6000°K are analyzed. (R.V.J.)

22126 SPECTRA OF RF RADIATION FROM HX-DEVICE. Yamamoto, Takayoshi; Akimune, Hideo (Osaka Univ.). Technol. Rep. Osaka Univ., 17: 291-301(Oct. 1967).

Among a number of experiments on the HX Device (High-energy molecular-ion injection-type mirror device), which is capable of producing high-temperature plasmas, special note is taken of the experiments on rf radiation emitted from the device. The most remarkable radiations are observed near integral multiples of ion cyclotron frequencies, the origin of which is well interpreted by the concept of low-density instability of double distribution proposed by Hall et al. Parameter dependence of the intensities of these radiations and existence of something like fine structures subsidiary to the ion cyclotron harmonics are also reported. (NSA of Japan)

22127 SPECTROSCOPIC OBSERVATIONS ON INDUCTION-COUPLED PLASMA FLAMES IN AIR AND ARGON. Eckert, H. U. (Lockheed California Co., Burbank); Kelly, F. L.; Olsen, H. N. J. Appl. Phys., 39: 1846-52(Feb. 15, 1968).

Plasma flames in argon and air have been maintained at atmospheric pressure by rf induction in a 100-mm-wide quartz tube for extended times with only forced air required for tube cooling. For air, a rotational temperature of 6300°K at the central point of the induction zone was determined from intensity ratios of both sextet components and unresolved sextets in the 0, 0 band of the $N_2(2+)$ system. Absolute intensity measurements in this band and in the 0, 0 band of the $N_2^+(1-)$ system yielded probabilities of 1.34×10^7 sec^{-1} ± 14% for the $C\,^3\pi_u - B\,^3\pi_g$ transition and 1.15×10^7 sec^{-1} ± 14% for the $B\,^2\Sigma_u^+ - X\,^2\Sigma_g^+$ transition, which agree well with values in the literature. Under the assumption of local thermal equilibrium (LTE) in the plasma, radial temperature distributions at the coil midsection were derived for both systems. Results agree within 7%, which supports the validity of the above values for transition probabilities and indicates that deviations from LTE are less than 10%. Average electron densities were determined for argon and air at the coil midsection from Stark broadening of the H_β line. For air a value of 5×10^{16} cm^{-3} has been found which is slightly above the equilibrium value. The value for argon is 1.7×10^{15} cm^{-3}. It correlates well with data from other sources which indicate that the average electron density in argon is inversely proportional to the tube radius. (auth)

22128 TEMPERATURE DETERMINATION FROM X RAY EMISSION OF THE TOKAMAK TM-3 APPARATUS. Shcheglov, D. A. JETP Lett. (USSR) (Engl. Transl.), 6: 365-6(Dec. 1, 1967).

Translated from Zh. Eksp. Teor. Fiz., Pis'ma Redaktsiyu, 6: 949-51(Dec. 1, 1967).

The soft x radiation (3 to 12 keV) was investigated by means of an amplitude analysis performed with a flow-through gas proportional counter as a detector. The spectra are presented. (M.O.W.)

22129 ION HEATING IN A TURBULENT PLASMA. Zavoiskii, E. K.; Nedoseev, S. L.; Rudakov, L. I. JETP Lett. (USSR) (Engl. Transl.), 6: 367-9(Dec. 1, 1967).

Translated from Zh. Eksp. Teor. Fiz., Pis'ma Redaktsiyu, 6: 951-3(Dec. 1, 1967).

Ion heating was investigated in a plasma turbulently heated by a current flowing along the magnetic axis of a mirror machine. The average ion energy was determined by a method based on simultaneous measurement of the energy and momentum of the flux of the plasma-ion charge-exchange neutrals. (M.O.W.)

22130 REDUCTION OF PLASMA LOSS FROM OPEN-ENDED MAGNETIC CONFINEMENT SYSTEMS BY MAGNETICALLY ROUGH WALLS. Tuck, James L. (Los Alamos Scientific Lab., N. Mex.). Contract W-7405-eng-36. Phys. Rev. Lett., 20: 715-18(Apr. 1, 1968). (LA-DC-9207).

Methods for possibly reducing the end loss from open-ended magnetic confinement systems are discussed. Lengthening processes, magnetically rough walls, and adiabatic processes are briefly discussed. (M.O.W.)

22131 PLASMA CONTAINMENT IN A THREE-DIMENSIONAL TRAP FORMED BY A MICROWAVE QUASIPOTENTIAL. Luk'yanchikov, G. S. (Lebedev Inst. of Physics, Moscow). JETP Lett. (USSR) (Engl. Transl.), 6: 354-6(Dec. 1, 1967).

Translated from Zh. Eksp. Teor. Fiz., Pis'ma Redaktsiyu, 6: 934-8(Dec. 1, 1967).

A three-dimensional quasi-potential trap was produced in a cylindrical resonator by exciting, with the aid of a decimeter-band microwave generator, an E_{011} mode in which the electric field is zero at the center. The plasma was generated by a spark gun. The confinement was investigated. (M.O.W.)

22132 INTENSE MAGNETIC FIELDS AND PLASMAS. Delcroix, J. L. (Faculte des Sciences, Orsay, France). pp 317-24 of Les Champs Magnetiques Intenses, leur Production et leurs Applications. Paris, Centre National de la Recherche Scientifique, 1967. (In French).

From International Colloquium on Intense Magnetic Fields, their Production and their Applications, Grenoble, France. See CONF-660921.

After a brief review of classical properties of ionized gases in magnetic fields, one looks for criteria corresponding to different classes of possible experiments. The fields varying from 10^5 to 10^7 seem to be mainly useful for research in the following domains: quantum effects in electron dynamics, magnetohydrodynamic properties, anisotropy effects at high pressures, diamagnetic effects, and confinement in "fast" devices for controlled fusion. (auth)

22133 AVERAGE MINIMUM HELIOTRON MAGNETIC FIELD WITH INNER RING CONDUCTORS. Mohri, Akihiro; Matsuda, Shinzaburo (Kyoto Univ.). Kakuyugo-Kenkyu, 20: 165-92(Jan. 1968). (In Japanese).

A magnetic field having an average minimum-B configuration can be produced by immersing the negative coils of the Heliotron field in the plasma. Assuming the sheet current model, the general expression of this magnetic field is deduced. Some of the field properties such as the effect of the position of the neutral lines are discussed. In this configuration, the neutral lines, on which the magnetic field intensity is zero, encircle the minor axis of the torus, while they encircle the major axis in the case of the toroidal multipole. The separatrix is formed by the field lines which cross the neutral lines, and the bottom of the magnetic well is on the separatrix. The equivalent potential, $U = -\oint dl/B$, increases monotonically from the separatrix towards the wall of the vacuum vessel, so that the plasma injection into the well may be easily attained. Besides, the potential in the region near the wall is higher than that on the magnetic axis. (NSA of Japan)

22134 THE PROPOSAL ON THE PLASMA CONFINEMENT BY THE HELIOTRON MAGNETIC FIELD WITH INNER CONDUCTORS. Uo, Koji (Kyoto Univ.). Kakuyugo-Kenkyu, 20: 193-9(Jan. 1968). (In Japanese).

The plasma confinement by the Heliotron magnetic field with helical or poloidal inner conductors is proposed. This field forms a magnetic well of the potential, $U = -\int dl/B$, and the bottom of the potential well is in the region near the separatrix. When the plasma fills up the region inside maximum U surface, the plasma is stable for flute instability. The plasma inside the separatrix is stable as far as the region just outside the separatrix is filled up by plasma. The plasma outside the separatrix will be lost gradually due to the supporter loss. When the plasma density just outside the separatrix becomes sufficiently low, the plasma inside the separatrix starts to leak out from the region inside the separatrix due to instability. Therefore, if one compensates for the plasma loss due to the supporter by gun plasma injection or other means and keeps the plasma density just outside the separatrix constant, the plasma inside the separatrix will be confined stably and the confinement time will be extended considerably. The substitution of the old plasma by the newly injected plasma will take place only in the region outside the separatrix, but not inside the separatrix. (NSA of Japan)

Diagnostics of Plasma

22135 (AE-313) ELECTRON TEMPERATURE OF A PARTIALLY IONIZED GAS IN AN ELECTRIC FIELD. Robben, Frank (Aktiebolaget Atomenergi, Stockholm (Sweden)). Mar. 1968. 15p. Dep.

The electron temperature of a partially ionized gas in an electric field can be determined by the collision rate for momentum transfer and the collision rate for energy transfer. Mean values of these rates are defined such that a simple expression for the electron temperature is obtained, and which depends, among other things, on the ratio of these mean rates. This ratio is calculated in the Lorentz approximation for power law cross sections, and also as a function of the degree of ionization for a helium plasma. It is pointed out that the complete results of refined transport theory can be used in calculating electron mobility and electron temperature in a multicomponent plasma without undue difficulty. (auth)

22136 (MATT-563) KINETIC THEORY OF A HIGHLY NEGATIVE LANGMUIR PROBE. Su, C. H. (Princeton Univ., N. J. Plasma Physics Lab.). Jan. 1968. Contract AT(30-1)-1238. 21p. (CONF-670810-8). Dep. CFSTI.

From 8th International Conference on Phenomena in Ionized Gases, Vienna, Austria.

Spherical Langmuir probes in a static plasma with $R \gg \lambda \gg \lambda_D$ are studied, where R is the probe radius, λ the collision mean free length between charged and neutral particles, and λ_D the Debye length. The electrons are taken to have a Boltzmann distribution. Boltzmann's kinetic equation with a simple Krook collision term is used for ions. There are three physically distinct regions in plasmas around a probe. Starting far from the probe, one has: (1) Diffusion-dominated neutral region. This is obtained readily by applying the Chapman–Enskog method to the ion kinetic equation. (2) Kinetic neutral region. The diffusion process breaks down at a distance of the order of the mean free path from the probe surface. The existence of such a region depends on $\epsilon^2 \equiv (\lambda_D/R)^2\,(R/\lambda)^3 \ll 1$. It is shown that the potential and density in this region are double-valued, with the electric field going to infinity at a certain point. For sufficiently small ϵ^2 the location of this singular point enables one to compute the saturation ion current. (3) Charge-separation sheath. This is essentially a collision-free region for all reasonable probe potentials. A detailed analysis is given for the purpose of constructing a current–voltage characterization. Finally, a numerical computation for the kinetic neutral and sheath regions is given. (auth)

22137 (TID-24331, pp 153-65) GASEOUS ELECTRONICS. (Massachusetts Inst. of Tech., Cambridge. Research Lab. of Electronics).

Measurements were made of electron-atom collision frequencies in an argon afterglow plasma. The experimental results are described along with theoretical considerations. (M.O.W.)

22138 (TID-24331, pp 217-30) INTERACTION OF LASER RADIATION WITH PLASMAS AND NONADIABATIC MOTION OF PARTICLES IN MAGNETIC FIELDS. (Massachusetts Inst. of Tech., Cambridge. Research Lab. of Electronics).

Research is reported on the following two areas: incoherent scattering of light from a plasma and velocity scattering of charged particles in perturbed magnetic fields. (M.O.W.)

22139 DIAGNOSTICS OF AN ARGON PLASMA BY APPLICATION OF CONTINUOUS RADIATION. Guendel, H.; Neumann, W. Monatsber. Deut. Akad. Wiss. Berlin, 9: 604-8(1967). (In German).

The use of the continuous spectral emission from an argon plasma for the diagnosis of the plasma is studied. The frequency dependence and temperature dependence of the spectral emission coefficient are derived and illustrated by experimental data. (J.S.R.)

22140 NORMAL AND ANOMALOUS CONDUCTIVITY IN A TOROIDAL DISCHARGE FROM THOMSON SCATTERING MEASUREMENTS. Dimock, D.; Mazzucato, E. (Princeton Univ., N. J.). Phys. Rev. Lett., 20: 713-14(Apr. 1, 1968).

Thomson scattering measurements were carried out on the Model C Stellarator. The plasma used was an ohmically heated discharge in hydrogen. The ruby laser and seven-channel monochromator were arranged to permit spatial scanning along a diameter of the discharge. (M.O.W.)

22141 ASYMMETRICAL PROBE METHODS FOR MEASUREMENTS IN STREAMING PLASMA. Miroshiba, Shigos; Nnakano, Yoshiei (Tokyo Inst. of Tech.). Jap. J. Appl. Phys., 7: 311-20(Apr. 1968).

Methods are described for measurements of the ion temperature, electron temperature, and the plasma density of streaming plasma by inserting two or three plane probes, each of which has a parallel or perpendicular face to the direction of the stream. These methods need exact formulations of the ion saturation currents of each of the probes to calculate the ion temperature and density. These are also determined by considering the effect of penetration of the electron into the ion sheath. By the use of these methods, furthermore, the ion and electron temperatures and the density of the plasma made by the coaxial plasma gun were measured to prove the utility of these methods. (auth)

22142 ERGEBNISSE DER PLASMAPHYSIK UND DER GASELEKTRONIK. BAND 1. (Results of Plasma Physics and Gas Electronics. Volume I). Rompe, Robert; Steenbeck, Max (eds.). Berlin, Akademie-Verlag, 1967. 497p.

Plasma diagnostic methods which depend on the determination of the intensities in line and continuous spectra in emission and absorption, on the determination of the refractive index, and on the measurement of line profiles and line displacements, are described in detail. Some special methods of spectroscopic plasma diagnosis, which define the electron temperature and the particle density in rarefied plasma, are also considered. The theory of the propagation of small perturbations in nondissipative unlimited magnetohydrodynamic media is described with the application of mathematical relations. The study begins with the elementary propagation properties of elementary waves in homogeneous media. (tr-auth)

22143 PLASMA PHYSICS RESEARCH AND ENGINEERING. Camden, N. J., Radio Corporation of America, 1966. 80p. (NP-17372).

Eighteen papers are included on various plasma studies. These include diagnostic techniques, ionospheric and geophysical phenomena, and other related studies. (M.O.W.)

Kinetics of Plasma

Refer also to abstracts 21837 and 22143.

22144 (AE-311) SPECTROSCOPIC STUDY OF RECOMBINATION IN THE EARLY AFTERGLOW OF A HELIUM PLASMA. Stevefelt, J. (Aktiebolaget Atomenergi, Stockholm (Sweden)). Feb. 1968. 49p. Dep.

Some properties of a decaying helium plasma have been studied using time resolved spectroscopy and probe diagnostics. The plasma was produced in a pulsed, repetitive, hot cathode discharge in helium at a pressure eleven torr, and the light emitted in the afterglow of the discharge was measured by means of a spectrometer-photomultiplier combination. Single photoelectrons were counted on a scaler during a preset gate time of each discharge cycle, and after a preset number of cycles recorded on punched tape. The spectrometer was calibrated for absolute intensity measurements of the spectral lines of atomic helium. The overall conductance of the positive column was determined by measuring the voltage difference between two probes inserted into the plasma, passing a very small current pulse between the anode and cathode in the afterglow. Heavier current pulses were used to heat the free electrons selectively, thus providing so-called "afterglow quenching." From the measured absolute intensities of the helium lines, the number densities of the excited states of helium were calculated. All levels with principal quantum number $n \geq 8$ were found to be in near Saha equilibrium with the free electrons at a temperature 1275°K in the early afterglow (15 to 35 μs after end of the discharge). By measuring the absolute intensities of some of the molecular helium bands, an estimate of the rate of conversion of atomic helium ions into molecular helium ions was obtained. The atomic line radiation, as well as the molecular band radiation, was assumed to result from collisional-radiative recombination of atomic and molecular helium ions, respectively. The rate of recombination down to the metastable level $n = 2$ was obtained from the measured line intensities. By adding the rate of ambipolar diffusion, calculated from known literature data, quite good agreement with the measured decay rate for the electron density was found. The measured line intensities were also used to calculate the collisional deexcitation rate constants for the excited states of helium. The measured plasma conductance was found to be in fair agreement with kinetic theory, taking into account collisions of electrons with both neutral atoms and with charged particles. When a current pulse is applied in the early afterglow, the spectroscopically determined electron temperature is, however, smaller than predicted by theory. Also the dependence of the recombination coefficient upon electron temperature was found to be somewhat different from what the collisional-radiative model predicts. (auth)

22145 (FOA-4-4341-23) ROTATIONAL MOTION OF MAGNETIZED PLASMAS. Witalis, E. A. (Forsvarets Forskningsanstalt, Stockholm (Sweden)). Mar. 1968. 9p. Dep.

Under the simplifying assumption of constant fractional ionization, a general relation is derived for the vorticity dependence on the fields and forces present in a magnetized plasma. It is shown that time and, for a moving plasma, space variations of the magnetic field will lead to rotation if the plasma has the usual tensor conductivity, i.e., exhibits Hall effect. (auth)

22146 (NP-17389) INDUCED FLUCTUATION AND RADIATION IN A MAGNETOPLASMA. Report No. 35. Ojo, AkinRemi (Columbia Univ., New York. Plasma Lab.). Feb. 1968. 121p.

The investigation of induced fluctuation and radiation in an infinite magnetoplasma is carried out in three parts. First, given, a priori, the electric fields of the fluctuation, a mechanism for the conversion of electrostatic to electromagnetic energy is postulated. Under the assumption that there is a group of "favored" charges to interact with the fluctuation fields, the transverse energy of the group as a function of time is related to the energy of the fluctuation. Secondly, the fluctuation induced by a realistic collection of electrons considered as a persistent process (beam) in a magnetoplasma, is examined in the linear regime with the object of obtaining the amplitude, rather than only the dispersion relation, of the fluctuation. This depends on a new approach to the problem of beam-plasma interaction treated totally as a stochastic (Wiener) process. The final part of the investigation consists of an experiment on a Q-machine cesium plasma. For the first time a 0.2-eV fully ionized quiescent plasma is induced to radiate about the second electron cyclotron harmonic frequency by the injection of an electron beam, which by itself is incapable of producing the observed radiation. Certain features of the results are qualitatively consistent with elements of the theory. (M.O.W.)

22147 (TID-24331, pp 121-52) PLASMA PHYSICS. (Massachusetts Inst. of Tech., Cambridge. Research Lab. of Electronics).

Research results are reported in each of the following areas: (1) exact nonlinear undamped waves in a collisionless plasma, (2) diffusion wave experiment, (3) helium afterglow density measurements utilizing a narrow-band far-infrared interferometer, and (4) ion temperature measurements in the hollow-cathode arc plasma. (M.O.W.)

22148 (TID-24331, pp 167-209) PLASMAS AND CONTROLLED NUCLEAR FUSION. (Massachusetts Inst. of Tech., Cambridge. Research Lab. of Electronics).

Research progress is reported on the following: beam-plasma discharge; spiraling beam-plasma interactions; beam-space-

charge wave interaction with the background wave in a cold plasma waveguide; critical lengths for absolute instabilities; particle flux measurements in a hollow-cathode arc; a possible very intense pulsed continuum x-ray source; microwave instabilities in a semiconductor subjected to dc electric and magnetic fields; and interactions of acoustic waves with drifting electrons in a magnetic field. (M.O.W.)

22149 (TID-24331, pp 211-15) SPONTANEOUS RADIO-FREQUENCY EMISSION FROM HOT-ELECTRON PLASMAS. (Massachusetts Inst. of Tech., Cambridge. Research Lab. of Electronics).

A discussion is presented on the diamagnetism of a radially inhomogeneous plasma in a uniform magnetic field. (M.O.W.)

22150 (TID-24334) INVESTIGATION OF UNIVERSAL PLASMA INSTABILITIES. Quarterly Report No. 7, June 1-August 31, 1967. Lashinsky, H. (Maryland Univ., College Park. Inst. for Fluid Dynamics and Applied Mathematics). Contract AT(40-1)-3405. 11p. Dep. CFSTI.

A preliminary evaluation of the electron bombardment system for the Q device was made. This system makes use of a sealed-off bombardment diode. A summary of the motivation, design considerations, and the results of preliminary tests of this diode are given. (M.O.W.)

22151 EXPERIMENTAL DETERMINATION OF THE THERMAL CONDUCTIVITIES OF ARGON PLASMAS. Asinovskii, E. I.; Kirillin, A. V. (High-Temperature Scientific Research Inst., Moscow). Int. Chem. Eng., 7: 281-8(Apr. 1967).

Determination of the thermal conductivities of Ar plasmas at atmospheric pressure and temperatures from 10,000 to 13,000°K is reported. A stabilized electric arc was used to attain the required temperatures. The effect of gas flow rate on the electrical characteristics of the arc was also studied, it being assumed that the role of convective mixing of the plasma in the cooling of the arc column could be determined in this way. It was shown that as the gas flow rate was changed by almost an order of magnitude (from 2.0 to 20 N cm^3/sec), the electrical field intensity remained unchanged in all cases and was uniform over the whole length of the stabilizing device. The possibility of turbulization of the plasma in the arc columns of very intensive cathode plasma jets was considered. To determine the degree of interaction of these jets with the arc column, electrical measurements were carried out for 2 possible directions of the gas stream along the arc. The results showed that the effect of the cathode jet on the electrical field intensity is small, and need not be taken into account in the further evaluation of these data. The same conclusion was reached from the fact that the use of cathodes of different shapes (rods or tubes) did not lead to noticeable changes in the field intensity of the arc or in the radial temperature distribution in the channel. The role of radiation in the energy balance of the central part of an Ar arc was examined. (BBB)

22152 MICROWAVE DETERMINATION OF ELECTRON DENSITY IN A NARROW PLASMA COLUMN. Sen, S. K.; Ghoshal, A. K. (Inst. of Radio Physics and Electronics, Calcutta). J. Inst. Telecommun. Eng., 11: 441-9(1965).

An investigation on electron density in a mercury discharge narrow plasma column has been made. Admittance offered by the plasma column, introduced in a rectangular waveguide parallel to the electric field vector of TE_{10} mode, has been measured. Electron density is calculated from its relation with the admittance. The change in resonant frequency of a cylindrical cavity in TM_{010} mode, with the plasma column placed coaxially in it, has also been noted. The electron density is determined from a relation between it and the change in resonant frequency of the cavity, based on a perturbation theory. In both these methods, the effect of the plasma container is not properly taken into consideration. A more accurate method of evaluation of the electron density has therefore been developed. The cylindrical cavity with the coaxial plasma column is tuned. Maxwell's equations are applied for different media in the cavity, i.e., plasma, its container, and the region between the container and the cavity wall. Transcendental equations relating the operating frequency and electron density have been derived, applying proper boundary conditions. Solution of the transcendental equation gives the electron density. The results obtained at different discharge currents of the plasma column by the admittance, perturbation, and exact methods are compared and discussed. (Indian Sci. Abstr.)

22153 COMPRESSIONAL ALFVEN WAVE PROPAGATION BELOW ION CYCLOTRON FREQUENCY. Cross, R. C.; Lehane, J. A. (Univ. of Sydney). Aust. J. Phys., 21: 129-38(Apr. 1968).

When the compressional wave cutoff frequency is below ion cyclotron frequency, both compressional and torsional Alfvén waves may be present simultaneously. Compressional wave measurements in this regime are particularly important because of their relevance to certain ion cyclotron resonance heating experiments. Measurements are presented that deal mainly with the dispersion of the azimuthally symmetric wave and the radial variation of its magnetic field components. The observed radial variation agrees with that expected theoretically, as does the change in the relative amplitudes of the field components with frequency. The dispersion relation measurements, made in a decaying plasma, yield values of the plasma parameters that change with time after breakdown in a way consistent with spectroscopic observations. These measurements bring out the importance of ion-neutral coupling and yield a value of the ion-neutral momentum transfer cross section of $7.5(\pm 2.5) \times 10^{-15}$ cm^2, which is consistent with estimates made from torsional wave studies. (auth)

22154 QUANTUM MECHANICAL CALCULATION OF THE RADIAL DISTRIBUTION FUNCTION FOR A PLASMA. Barker, A. A. (Univ. of Adelaide). Aust. J. Phys., 21: 121-7(Apr. 1968).

A quantum mechanical calculation of the radial distribution function $g_{q.m.}(r)$ for unlike particles in a hydrogenous plasma is presented. Results for a neutral plasma over a range of temperatures show that $g_{q.m.}(r)$ differs significantly from the corresponding classical distribution function $g_c(r) = \exp(\beta e^2/r)$ when r is less than a chosen distance r_1, the value of which is temperature-dependent. The effect of shielding, the relative contribution from scattered and bound states, and the relation to percentage ionization are discussed. (auth)

22155 LAMINAR PLASMA JETS FLOWING OUT TO FREE AIR. Valentin, Pierre; Boulanger, Philippe; Vuagnat, Jean; Limare, Armand (Faculte des Sciences de Rouen, Seine-Maritime, France). Compt. Rend., Ser. A and B, 266: 296-9 (Jan. 29, 1968). (In French).

The importance of diffusion in plasma jets flowing out to free air is shown. The composition of the jets is determined and an evaluation is made of the temperatures of Ar and He jets. The variation of the quantity of movement flux was determined. (J.S.R.)

22156 PLASMA PHYSICS. Winter, S. D. Nucleus (Paris), 8: 499-502(1967). (In French).

The principal lines of research in the study of energy exchange between plasmas and electromagnetic waves, giving rise to microinstabilities, are briefly outlined for the period since 1958. The principal results obtained with the experimental installations Icare, Pleiade, and Circe are discussed. (J.S.R.)

22157 INVESTIGATIONS OF THE CONCENTRATION OF CHARGED PARTICLES AND ITS VARIATION IN TIME IN A PLASMA OF HIGH-IMPULSE DISCHARGE. Petrakev, A.; Voros, Tibor; Paszkalev, K. Magy. Kem. Foly., 74: 14-16 (Jan. 1968). (In Hungarian).

The concentration (N) of charged particles has been determined from the broadening of the H_β line in a plasma of high-impulse discharge at atmospheric pressure. A mechanical device resolved in time the spectrum of the high-impulse discharge. The half-width of the H_β line has been measured in different moments of time, and the variation of N has been determined as a function of the time of discharge. In the first 120 μs of the impulse, N changes from 10^{16} to 10^{17} cm^{-3}, and it has a maximum at ~40 μs after the beginning of the discharge. (auth)

22158 OSCILLATION-TYPE STRUCTURE OF A QUASI-STEADY MAGNETOHYDRODYNAMIC SHOCK WAVE IN PLASMA. Dolgov-Savel'ev, G. G.; Malinovskii, V. K.; Nesterikhin, Yu. E. Zh. Prikl. Mekh. Tekh. Fiz., No. 4, 111-12(July-Aug. 1967). (In Russian).

Whereas earlier studies of the structure of collision shock waves in a plasma were devoted primarily to unsteady shock waves, the only data available for steady shock waves are those obtained with artificial satellites and, concerning the interaction of the solar wind with the magnetosphere of the earth, and the experimental data are quite skimpy. The authors have therefore constructed an experimental setup which incorporates the principal elements of a plasma injector (Magn. Gidrodin., No. 1, 80(1965)) and a Michelson interferometer (Magn. Gidrodin., No. 2, 32(1965)). The shock wave was produced by having a stream of charged plasma flow with supersonic velocity around a cylinder (10-mm diameter, 80-mm length) perpendicular to the generatrix of the cylinder. The light source for the interferometer was a ruby laser operating in the Q-switched mode. A framing camera was used to obtain the flow picture at exposures 2×10^{-8} sec. The working gas was hydrogen. The study showed that with increasing magnetic field an increase took place in the width of the shock-wave front, whereas the intensity of the wave decreased and the angle between the propagation of the shock wave and the stream direction increased. In very strong

magnetic fields and for oblique incidence, the shock wave acquires an oscillatory profile. The period of this profile agrees with the theoretical predictions. (ATD)

22159 STRUCTURE OF SHOCK WAVES OF AN ELECTRODELESS DISCHARGE IN AIR AND IN ARGON. Petchek, Z. A.; Soloukhin, R. I.; Toktomyshev, S. Zh. Zh. Prikl. Mekh. Tekh. Fiz., No. 4, 104-10(July-Aug. 1967). (In Russian).

The results are presented of systematic measurements of plasma temperature distribution behind the front of strong shock waves in air and argon (to which about 1% hydrogen was added). The plasma was produced by discharging a capacitor into a coil surrounding the discharge tube. The gas temperature behind the shock wave front was measured by three independent methods: (1) determination of the relative intensities of two hydrogen spectral lines Hα and Hβ, using a procedure described elsewhere; (2) determination of the time variation of the plasma electron density by sweeping the luminescence spectrum and determining the half-width of the Hβ emission line; and (3) hydrodynamically, by placing a cylinder at different points in the hypersonic plasma stream and taking streak photographs of the resultant shock waves. The latter method was proposed by the authors earlier and the present results show it to be feasible and to have certain advantages over the other two. The results reveal no deviations from thermodynamic equilibrium, and show that the main shortcoming of gas-discharge tubes, namely the shrinking or even total absence of a hot "stopper" of compressible gas ahead of the propelling gas plunger, is not eliminated by using an electrodeless discharge. Such discharges can be used only for certain minimal values of Mach numbers, ranging from 16 to 17 for argon to 25 to 40 for air. (ATD)

22160 EXPANSION OF A PLASMOID OF VARIABLE CONDUCTIVITY IN AN EXTERNAL MAGNETIC FIELD AT A SMALL PARAMETER OF HYDROMAGNETIC INTERACTION. Cherepanov, A. N. Zh. Prikl. Mekh. Tekh. Fiz., No. 4, 14-20(July-Aug. 1967). (In Russian).

A study is made of the inductive interaction of an expanding plasmoid, whose variable conductivity depends on temperature, with an external uniform magnetic field given in the form of an arbitrary time function. Under the assumption of the smallness of the parameter of hydromagnetic interaction (the product of the Reynolds magnetic number and of the ratio between the characteristic magnetic pressures and the static pressure of the plasma), two problems are solved: the expansion at a constant rate and the expansion in a vacuum. Plasma operation A against electric volumetric forces and Joule losses Q in the plasma are calculated per unit of time. A comparative analysis is made of the degree of isoentropicity of the expansion process or internal efficiency $\eta = (A - Q)/A$ as a function of the Reynolds magnetic number, the adiabatic rate, and the shape of the plasmoid (either plane- or axisymmetric). The result of the calculation may be used for some evaluations of the magnetohydrodynamic method of thermal-to-electric energy conversion. (ATD)

22161 PRIMARY ELECTRON ENERGY SPECTRUM AND THE POTENTIAL DROP IN THE PENETRATING PLASMA OF THE PENNING DISCHARGE WITH A HOT CATHODE. Romanyuk, L. I. (Kiev Inst. of Physics). Ukr. Fiz. Zh., 13: 312-16(Feb. 1968). (In Russian).

The data on the energy spectrum of the primary electrons going out of the Penning discharge with a hot cathode into the penetrating plasma were obtained by means of the electrostatic velocity analyzer. The correlation between the energy spectrum of the electrons and the potential drop value in the penetrating plasma was found. (auth)

22162 REFLECTION OF ELECTROMAGNETIC WAVES FROM A MOVING MAGNETOACTIVE PLASMA LAYER. Kondratenko, A. N. (Kharkov Inst. of Physics and Tech.). Ukr. Fiz. Zh., 13: 236-43(Feb. 1968). (In Russian).

Under the approximation of weak space dispersion, reflection of electromagnetic waves from a moving homogeneous plasma layer placed in a stationary magnetic field is considered. The particle scattering at the boundary surface is assumed to be specular or diffuse. The coefficients of reflection, transmission, and absorption of the energy are found. (auth)

22163 TRANSFORMATION AND SCATTERING OF ELECTROMAGNETIC WAVES IN PLASMA PLACED IN A STRONG ELECTRIC FIELD. Angeleiko, V. V. (Kharkov State Univ.). Ukr. Fiz. Zh., 13: 177-84(Feb. 1968). (In Russian).

Processes of transformation and scattering of electromagnetic waves in a partly ionized plasma placed in a strong electric field E_0 are considered. The cross sections of these processes are shown to increase sharply if E_0 approaches a certain value E_c. Spontaneous glow of plasma caused by the transformation of random longitudinal waves into transversal electromagnetic ones is studied. The intensity of this glow is shown to increase sharply if $E_0 \rightarrow E_c$. (auth

22164 ABSORPTION SPECTRUM OF A MAGNETOPLASMA DIELECTRIC IN A RESONANT CAVITY. Kent, Gordon; Heintz, Roger (Syracuse Univ., N. Y.). J. Appl. Phys., 39: 1741-6 (Feb. 15, 1968).

A simple theory based on plane waves in a cold magnetoplasma is proposed to account for experimentally observed absorption bands for transverse electric waves impinging on a microwave cavity. When the cyclotron frequency is equal to the resonant frequency of the TE_{111} mode of a cylindrical cavity, the data show a three-fold split of the resonance. The outer frequencies are separated by the plasma frequency, and their geometric mean is the cyclotron frequency. The third resonance is shifted by an amount proportional to the square of the plasma frequency, and it occurs only when the cyclotron frequency is very nearly equal to the empty cavity resonance. The simple theory accounts quantitatively for these three absorption bands, and it is in qualitative agreement with other observations. The experiments were performed on a microwave discharge in argon at a pressure of 150 μ and for a range of plasma frequencies from 1.00 to 2.25 GHz. (auth)

22165 NEW MULTIPOLAR MODE IN BOUNDED GYROTROPIC PLASMA. Bevc, Vladislav (Aerospace Corp., Los Angeles). J. Appl. Phys., 39: 1492-1502(Feb. 15, 1968).

Multipolar modes in a cylindrical, axially magnetized, cold, collisionless plasma that propagate near the cyclotron frequency are studied quantitatively. Examination of electromagnetic field patterns shows that in addition to the well-known spectrum of cyclotron modes there exists at positive azimuthal eigenvalues ($n > 0$ in $\exp jn\phi$) a mode that is distinguished by a different type of field pattern. The electric field of this mode is predominantly solenoidal, in contrast with the cyclotron modes, where a substantial part of the electric field is lamellar. This mode may be of importance in thick-beam parametric amplifiers at microwave frequencies (X-band) and in beam–plasma interaction near cyclotron frequency. (auth)

22166 INTERACTING COMPONENTS IN BEAM-GENERATED BEAM–PLASMA SYSTEMS. Frey, Jeffrey (Rutherford High Energy Lab., Chilton, Eng.). J. Appl. Phys., 39: 1887-9 (Feb. 15, 1968).

The ratio of the density of plasma electrons or ions, in excess of those required for neutralization, to the electron density in the beam generating the plasma is calculated. It is assumed that ambipolar diffusion is the only mechanism by which these particles drain from the system once the beam is neutralized. Curves of the ratio, as a function of pressure and beam voltage, are given for hydrogen and nitrogen plasmas. Agreement of a result for an argon plasma with experiment is good. In hydrogen, the density of secondary electrons or ions becomes comparable to the beam density at pressures of the order of 10^{-6} Torr; in nitrogen, the densities are comparable nearer 10^{-5} Torr. However, since the wave interactions that occur in a system will depend on the relative magnitudes of the components' plasma frequencies, interactions between the beam and secondary plasma electrons may be of importance at pressures lower than those cited. (auth)

22167 PLASMA TRANSIENT RESPONSE AND THE DETERMINATION OF COLLISION DATA. Bruce, R. L.; Crawford, F. W.; Harp, R. S. (Stanford Univ., Calif.). Contract AT(04-3)-326. J. Appl. Phys., 39: 2088-94(Mar. 1968). (SU-IPR-186).

The transient response of a magnetoplasma subjected to a short pulse at the electron gyrofrequency, which is applied with its electric field perpendicular to the static magnetic field, is discussed. Experimental parameters are readily realized in which the decay of the transient-response envelope is influenced most strongly by collisions. Under these conditions, fundamental collision data may be derived from observations of the decay rate. Experiments are described in which elastic electron–neutral collisions have been studied in argon. The results of these experiments, made in a far from ideal system, are sufficiently close to accepted data to warrant the conclusion that, with further development, magnetoplasma transient-response studies would provide a valuable new technique for obtaining collision data. They should be particularly useful in the low energy range (≤1 eV). Suggestions are made for appropriate improvements and further applications of the method. (auth)

22168 EXCITATION OF OSCILLATIONS BY AN ELECTRON CURRENT IN A WEAKLY IONIZED PLASMA. Pocobelli, G. (Univ. of Saskatchewan, Can.). Can. J. Phys., 46: 171-6(Feb. 1, 1968).

We investigate in the framework of linear kinetic theory the

effect of neutrals on plasma oscillations generated by drift of the electrons in a boundless, stationary, homogeneous, Maxwellian plasma. It is assumed that collisions between charged particles and neutrals are dominant with respect to collisions between charged particles. The expected stabilizing effect of these collisions on the critical velocity and growth rate is confirmed and evaluated. Our results reduce to those of Klevans and Primack—the most accurate results to date for ion and electron plasma waves—in the collisionless, driftless case; to those of Bernstein and Kulsrud (with somewhat improved accuracy) in the collisionless case; and to those of Kadomtsev in the case of very high electron–ion temperature ratios and $k \ll k_{D_e}$, the wave number corresponding to the electron Debye length. (auth)

22169 REACTION OF CONTRACTED GLOW DISCHARGE TO UNIFORM ROTATION. Iorish, Yu. I.; Dvoskin, V. S. (Moscow Evening Metallurgical Inst.). JETP Lett. (USSR) (Engl. Transl.), 6: 357-9(Dec. 1, 1967).

Translated from Zh. Eksp. Teor. Fiz., Pis'ma Redaktsiyu, 6: 938-42(Dec. 1, 1967).

A contracted glow discharge in the form of a plasma pinch is produced in a cylindrical tube, filled with air at $\sim 10^{-1}$ atm, with electrode gap $l \approx 10$ μ and located at a distance $L \approx 5$ mm from the cathode. The reaction of the discharge to uniform rotation is investigated. (M.O.W.)

22170 PLANE COLLISIONLESS SHEATHS BETWEEN FIELD-MODIFIED EMITTING ELECTRODES AND THERMALLY IONIZED PLASMAS EXEMPLIFIED BY CESIUM. Morris, James F. (Lewis Research Center, Cleveland). J. Appl. Phys., 39: 1705-17(Feb. 15, 1968).

A theory for plane collisionless sheaths separating plasma ionized by thermal electrons from emitting electrodes affected by sheath fields is described. Examples for cesium plasmas and thermionic-diode configurations show sheath effects over ranges of conditions: temperatures from 1400 to 2400°K for electrodes, from 1600 to 2400°K for plasma atoms and ions, and from 1700 to 2700°K for plasma electrons; plasma-electron number densities from 10^{12} to 10^{16} cm^{-3}; and work functions from 1.5 to 5 V. Sheath drops from 0 to 2.1 V and net currents from 0 to over 100 A cm^{-2} result. Overall sheath characteristics correlate with work function minus plasma potential, plasma-electron concentration (N_{ep}), electrode temperature (T_E), and an emission Debye length $\lambda_{DE} \approx 6.9(T_E/N_{ep})^{1/2}$. Effective sheath widths range from 1.7 to 2.6 emission Debye lengths. (auth)

22171 RADIAL INJECTION OF SEVERAL PLASMA CLUSTERS. Umarov, G. Ya.; Alimov, A. K. (Inst. of Physics and Tech., Tashkent). Izv. Akad. Nauk Uzb, SSR, Ser. Fiz.-Mat. Nauk, No. 6, 74-5(1967). (In Russian).

Studies were made of several clusters injected into a vacuum chamber cut out from a thick organic glass with five openings. High-speed photography was used to obtain a picture of plasma clusters injected by five jets. The cluster entered into the center of the chamber every 3 μsec and lasted 4.5 μsec, after which it disintegrated. In the presence of a transverse field, the plasma formed a spiral. (R.V.J.)

22172 THEORY OF ION RESONANCE. Bogdanov, A. V. (Moscow Regional Pedagogical Inst.). Izv. Akad. Nauk Tadzh. SSR, Otd. Fiz.-Tekh. Khim. Nauk, No. 1, 20-3(1966). (In Russian).

A theory is developed for calculating resonant excitation in a plasma. It is concluded that excitation of ion resonance in a plasma is possible with both electromagnetic and ultrasound frequencies; however, at present, excitation of ion-resonant oscillations with frequencies above 10^8 to 10^9 hertz is not technically feasible. It is suggested that this difficulty can be avoided by inserting in the plasma a piezoelectric crystal of dimensions such that its fundamental frequency (or harmonic of its fundamental mechanical frequency) coincides with ν_0. (TSS) (ATD)

22173 DETERMINATION OF RADIAL DISTRIBUTION OF ABSORPTION AND EMISSION COEFFICIENTS IN OPTICALLY DENSE PLASMA. Kolobova, G. A. (Tomsk Polytechnic Inst., USSR). Izv. Vyssh. Ucheb. Zaved., Fiz., No. 12, 75-80(1967). (In Russian).

The radial distribution of absorption and emission coefficients determined according to the known magnitudes of transparency and intensity in various plasma cylinders were calculated, using one algorhythm without Abel's conversions. Two hypothetical and two experimental examples were resolved with the order of error of ~2 to 4%. (R.V.J.)

22174 WAVE EQUATIONS FOR INHOMOGENEOUS WARM MAGNETOPLASMAS. Burman, R. (Victoria Univ., Wellington, New Zealand). Phys. Lett., 26A: 137-8(Jan. 15, 1968).

Linear wave equations are obtained for coupled waves in a generally inhomogeneous warm electron magnetoplasma. (auth)

22175 NON-LINEAR SETTLING OF ELECTRON PLASMA OSCILLATIONS. Gurevich, A. V. (Lebedev Inst. of Physics, Moscow). Z. Eksp. Teor. Fiz., 54: 522-35(Feb. 1968). (In Russian).

Dynamic nonstationary problems are considered of the nonlinear development of initial disturbances in unstable plasma. The growth of the plasma wave is investigated. It is shown that the wave field increases exponentially in accordance with Landau's linear theory only up to small amplitudes $\varphi_0 < 0.1\ m\gamma^2/2ek^2$ (where γ is the Landau increment (or damping), and k the wave vector). At larger values of φ_0 the growth of the field decreases, and at $\varphi_0 = 11.8\ m\gamma^2/2ek^2$ stops altogether. The wave becomes stationary. The cause is the direct effect of the wave field on the Landau pole. Nonlinear effects of this type have not been considered in quasi-linear theory. The development of an arbitrary local initial disturbance is considered. An asymptotic expression describing it at large values of t is obtained. (auth)

22176 KINETIC THEORY OF THE SYNCHROTRON INSTABILITY OF A SYSTEM OF RELATIVISTIC ELECTRONS IN PLASMA. Zheleznyakov, V. V.; Suvorov, E. V. (Gorky State Univ., USSR). Z. Eksp. Teor. Fiz., 54: 627-40(Feb. 1968). (In Russian).

Increments of an ordinary and extraordinary waves propagated across a magnetic field in a system of relativistic electrons and "cold" plasma are found by the method of a kinetic equation with a self-consistent field. Conditions are determined under which the results of the kinetic consideration coincide with those of the investigation of instability by the method of the Einsteinian coefficients. A change of the character of instability is studied versus increase of the width of the function of distribution of relativistic electrons over momenta, beginning from the δ function and up to a wide smooth distribution. If the distribution function is sufficiently wide, there originates a synchrotron instability of the type indicated earlier. (auth)

22177 EQUATION OF STATE OF AN EXCITED GAS OF RESONANCE ATOMS. Vdovin, Yu. A. (Moscow Engineering-Physics Inst.). Z. Eksp. Teor. Fiz., 54: 445-55(Feb. 1968). (In Russian).

A study is made of the effect of the resonance dipole–dipole interaction on the thermodynamic properties of an excited gas. It is assumed that only one electron level is excited, the population of this level being assigned independently. It is shown that quasi molecules consisting of excited and unexcited atoms form in a definite region of densities and temperatures. A contribution of multiparticle interactions is estimated. It is shown that the formation of metastable quasi molecules is possible. (auth)

22178 HOLOGRAPHIC MEASUREMENT OF THE LIGHT ABSORPTION. Ostrovskaya, G. V.; Zaidel, A. N. (Ioffe Inst. of Physics and Tech., Leningrad). Phys. Lett., 26A: 393-4 (Mar. 23, 1968).

The possibilities of using the holography in absorption measurements and its advantages in the measurements of the absorption coefficient of self-luminous objects are discussed. The transmission coefficients of a step attenuator and of a laser spark plasma were measured. (auth)

22179 PROPAGATION AND DAMPING OF LARGE-AMPLITUDE ION-ACOUSTIC WAVES IN A PLASMA. Sato, N.; Ikezi, H.; Yamashita, Y.; Takahashi, N. (Nagoya Univ., Japan). Phys. Lett., 26A: 437-8(Mar. 23, 1968).

Complicated behaviors of large-amplitude ion–acoustic waves are shown experimentally and are discussed qualitatively. (auth)

22180 TRANSITION BETWEEN TWO RESONANCES OF AN AUTORESONANT HIGH-FREQUENCY DISCHARGE. Leprince, P. (Faculte des Sciences, Orsay, France). Phys. Lett., 26A: 431-2(Mar. 23, 1968). (In French).

A hf plasma is created in a cavity; the density is such that the plasma is in a resonance state: main or secondary. The shift in the resonance frequency (mode E_{010}) and the luminosity give the measurement of the density versus absorbed power. (auth)

22181 NEGATIVE CONDUCTIVITY IN A NEON PLASMA. De Barbieri, O.; Maroli, C. (Univ., Milan. CNR, Milan). Phys. Lett., 26A: 442-3(Mar. 23, 1968).

It is shown that electron–molecule inelastic collisions can lead to a negative high-frequency conductivity in a neon plasma. (auth)

22182 RELATIVISTIC MAGNETOIONIC THEORY FOR DRIFTING PLASMA. Unz, H. (Univ. of Kansas, Lawrence). Radio Sci., 3: 295-8(Mar. 1968).

The relativistic magnetoionic theory for drifting plasma for arbitrary directions and large drift velocities is discussed and the general refractive index equation for the relativistic case is derived by using Lorentz transformation of the Booker quartic equation. Particular cases are found to agree with previous results. (auth)

22183 OBLIQUE WAVE PROPAGATION IN DRIFTING ISOTROPIC WARM PLASMA. Unz, H. (Rand Corp., Santa Monica, Calif.). Radio Sci., 3: 305-6(Mar. 1968).

The electromagneto-plasma-gas-dynamics equations for small signal theory are summarized for the warm, isotropic, drifting electron gas plasma, by using tensor notation. Taking oblique plasma wave propagation, a determinantal equation for the corresponding refractive index is derived. This is an extension for oblique incidence of a previous paper (Unz. 1966). (auth)

22184 REDUCTIVE PERTURBATION METHOD IN NONLINEAR WAVE PROPAGATION. I. Taniuti, Tosiya; Wei, Chauchin (Nagoya Univ., Japan). J. Phys. Soc. Jap., 24: 941-6 (Apr. 1968).

Presented is a class of nonlinear partial differential equations which admit a reduction to tractable nonlinear equations such as the Burgers and the Kortweg–deVries equation. The method of reduction is based on a singular perturbation expansion. Applications to the hydrodynamics and the plasma physics are discussed. (auth)

22185 EXCITATION OF ION CYCLOTRON HARMONIC WAVES IN A PLASMA BY A PERPENDICULARLY INJECTED ELECTRON BEAM. Yamamoto, Takayoshi; Suita, Tokuo (Osaka Univ.). J. Phys. Soc. Jap., 24: 933-40(Apr. 1968).

A weak electron beam is injected into a diffused hydrogen plasma perpendicular to the external magnetic field and signals of nonthermal level are observed on the frequency spectra near integral multiples of ion cyclotron frequencies. It is concluded from parameter dependences of these signals that the ion cyclotron harmonic waves, which suffer no Landau damping for perpendicular propagation, are excited as a result of coupling with the electrostatic beam wave. The observed frequency spectra are interpreted to be such grownup harmonic waves. (auth)

22186 ARC PLASMA DEVICE HAVING GAS COOLED ELECTRODES CONTAINING LOW WORK FUNCTION MATERIAL. Froehlich, Heinz (to Siemens-Schuckertwerke Aktiengesellschaft). U. S. Patent 3,343,027. Sept. 19, 1967. Priority date Aug. 10, 1963, Germany.

A method and device for heating gases in a plasma gun are described. The object of the invention is to minimize or overcome the difficulties encountered with plasma guns in which an arc between annular electrodes rotates in a transverse magnetic field. (M.O.W.)

Production of Plasma

22187 (CEA-R-3296) ETUDE CHRONOLOGIQUE DU PLASMA DE BERYLLIUM CREE PAR LE FAISCEAU D'UN LASER. (Chronological Study of Beryllium Plasma Produced by a Laser Beam). Langer, Philippe; Tonon, Gianfranco; Durand, Yves; Buges, Jean-Claude (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires). Dec. 1967. 61p. (In French). Dep.

Several investigations (ultrarapid cinematography, visible and ultraviolet spectroscopy, interferometry and charged particle detection) were made on beryllium plasma produced by a ruby laser having a maximum power of 9×10^{10} w/cm^2 at the focal point of an objective with a 6.7-cm focal length. The common characteristic of all these investigations is a time resolution which is sufficient to follow changes in the plasma during the entire duration of the laser pulse. The plasma visible from −60ns (time zero corresponds to the top of the laser pulse) undergoes a uniform acceleration from −30 to +5 ns; at this moment its velocity reaches a value of 10^7 cm/sec. Be^+, Be^{2+}, and Be^{3+} ions (corresponding to an ionization potential of 153 eV) are emitted by the plasma as soon as it is formed and have a maximum kinetic energy of 1,500 eV. The spectroscopic study of the plasma has shown the appearance of recombination lines of ionized beryllium and of lines of excited beryllium at +70 ns and +120 ns, respectively. These lines are still visible after +470 and +720 ns. Interferometric measurements carried out on this plasma have shown that its electronic density is not uniform and decreases rapidly at increasing distance from the target. For example, at 0.3 mm from the surface of the target, the density becomes equal to 2.3×10^{18} e/cm^3 and 5.5×10^{17} e/cm^3 at +20 and +40 ns respectively. (auth)

22188 (SC-DC-67-3217) LASER GENERATED PRESSURE WAVES. [Anderholm, N. C.] (Sandia Corp., Albuquerque, N. Mex.). Mar. 1968. Contract AT(29-1)-789. 3p. (CONF-680310-1). Dep. CFSTI.

From Meeting of the American Physical Society, Berkeley, Calif.

The problems associated with plasma production by laser-beam interactions with metallic surfaces are investigated. The investigation attempts to see if the problems such as expansion and turbulence could be reduced significantly by using the inertial properties of a transparent mass to clamp the plasma. (M.O.W.)

22189 DEFORMATION EFFECTS IN METAL UNDER LASER BEAM IMPACT. Zhiryakov, B. M.; Fannibo, A. K.; Yuryshev, N. N. Zh. Prikl. Mekh. Tekh. Fiz., No. 4, 145-6(July-Aug. 1967). (In Russian).

The action of laser beams on metal was experimentally investigated by using ruby laser pulses of 1×10^{-3} sec (λ = 6943 Å, energy ~10 J). The beam was focused (by a lens with a 56-mm focal length) on the surface of an iodide zirconium specimen. Conical craters, about 1 mm in diameter at the surface and up to 5-mm deep, resulted from the impact. The microhardness of the specimen material in the crater zone increased from 150 to 650 kg/mm^2. The results were practically independent of ambient air pressure, at least down to 5×10^{-5} mm Hg. The photographic recordings indicated a discrete and irregular character of the process. The substance was first carried away in a gaseous state (plasma), with the appearance of a liquid phase somewhat later. The plasma was ejected in the form of individual jets up to 15-mm high, with a time interval of about 10^{-6} sec, which corresponded to the frequency of spikes in the beam. It was established by a special scanning experiment that each spike can be considered as an individual impact resulting in its own microcrater, plasma ejection, etc. The time of formation of a crater calculated from the data of the experiment was of the order of 10^{-7} to 10^{-8} sec. The energy impact on the specimen at the focal point was equivalent to a pressure of about 10^6 atm. This leads to the conclusion that the phenomenon of hardening of the metal is the result of pressure impact rather than thermal effect, since the time of the crater formation (10^{-7} to 10^{-8} sec) is too short to permit an appreciable transfer of heat through conduction or through evaporation of the material. The excess energy acts as a mechanical blow from an explosion and results in a thin surface layer compressed to a higher degree of hardness. (ATD)

22190 CHARACTERISTICS OF A PLASMA GENERATOR WITH A TRANSPIRATION-COOLED POROUS ELECTRODE AND RELATED HEAT TRANSFER STUDIES. Li, J. S. (McMaster Univ., Hamilton, Ont. Iron Ore Co. of Canada, Ltd., Montreal); Wade, J. H. T. Can. Aeronaut. Space J., 12: 273-9(Sept. 1966).

A brief description is given of some of the performance characteristics of a dc plasma arc generator, including the influence of the electric field potential, between 18 to 25 V, at a field current of 70 to 100 A with a gas flow rate of 80 to 200 gm/min. The energy transfer efficiency of the generator was examined at different power inputs by measuring the energy losses to the cathode and anode holders. Preliminary results of forced convection heat transfer studies performed by means of the plasma generator are given. (IAA)

Stability of Plasma

22191 COMPENSATION OF A BALLOON INSTABILITY MODE OF A PLASMA IN A TOROIDAL SYSTEM. Shafranov, V. D. JETP Lett. (USSR) (Engl. Transl.), 6: 387-90(Dec. 15, 1967).

Translated from Zh. Eksp. Teor. Fiz., Pis'ma Redaktsiyu, 6: 975-8(Dec. 1, 1967).

A two-turn stellarator with circular magnetic axis and a system with a helical magnetic axis are used to show that the deepening of the magnetic well due to the plasma pressure cancels out the balloon instability if ideal plasma conductivity is assumed. (M.O.W.)

22192 PERSISTENCE OF THE FIREHOSE INSTABILITY IN HIGHLY RELATIVISTIC PLASMAS. Noerdlinger, Peter D.; Yui, Alexander Ko-min (Univ. of Iowa, Iowa City). Astrophys. J., 151: 901-5(Mar. 1968).

According to the firehose (or "gardenhose") instability criterion for nonrelativistic plasmas with anisotropic pressure, the plasma is unstable if and only if $P_{||} - P_\perp > B_0^2/4\pi$, where B_0 is the uniform magnetic field before perturbation. Lerche has stated that for a special example of a highly relativistic plasma this criterion must be replaced by an extremely different one, namely, instability for $P_\perp > P_{||}$ only. It is here shown that, upon correction of a mathematical error, the criterion for instability in Lerche's plasma becomes $-0.112 < B_0^2/2\pi(P_{||} - P_\perp) < 1$, which is much more like the

nonrelativistic criterion. It is also shown that, in spite of convergence difficulties during intermediate steps, power series in the wavenumber k happen to give the correct answer for small k, in contradiction to Lerche's assertion. It is suggested that the behavior of the firehose instability is not highly sensitive to the exact distribution of particle velocities. (auth)

22193 HYDROMAGNETIC STABILITY OF STATIONARY STREAMS. Solov'ev, L. S. Z. Eksp. Teor. Fiz., 54: 666-75 (Feb. 1968). (In Russian).

Conditions of hydromagnetic stability are derived for plasma stationary configurations (with non-zero velocities) close to cylindrically symmetric, provided the plasma conductivity is perfect and the velocities are small compared with the Alfvén velocity. (auth)

22194 HIGH-FREQUENCY STABILIZATION OF A PLASMA CYLINDER WITH CURRENT IN A LONGITUDINAL MAGNETIC FIELD. Gordienko, V. P.; Dubovoi, L. V.; Rolfe, I. M. Z. Eksp. Teor. Fiz., 54: 345-9(Feb. 1968). (In Russian).

It is shown that the Shafranov–Kruskal magnetohydrodynamic instability in strong-current discharges in longitudinal magnetic fields can be stabilized if the discharge current is modulated with a frequency larger than the increment of perturbation growth in a plasma column. The skinning process of a high-frequency current in a discharge is accompanied by an anomalously strong heating of the plasma. The heating can be explained by an experimentally possible excitation of the ion–acoustic microoscillations in the skin-layer region. (auth)

Shielding

Refer also to abstracts 22263, 22264, 22267, 22519, and 22524.

22195 GAMMA-RAY SCATTERING FROM POINT SOURCES BY INFINITE PLANE SURFACES. Kitazume, Mitsuyuki (Hitachi Ltd., Ozenji, Japan). J. Nucl. Sci. Technol. (Tokyo), 5: 98-103(Mar. 1968).

A method of evaluating the γ-dose rate resulting from a point source and scattered by a semi-infinite plane surface has been developed in the form of a single scattering formula. In this formula, the effect of multiple reflection within the medium is incorporated as buildup factor for the reflected γ-rays. Results of calculation with this formula are compared with values based on a semi-empirical expression using the differential dose albedo of a semi-infinite concrete expanse, and with experimental values obtained on dose rates of γ rays reflected by concrete and lead surfaces from point sources of ^{60}Co (1.25 MeV), ^{137}Cs (0.66 MeV) and ^{192}Ir (0.4 MeV). It is seen that the results of the calculation agree fairly well with the experimental results. (auth)

22196 ANALYSIS OF TOTAL GAMMA-RAY CROSS SECTIONS IN Al, Cu, AND Pb. Parthasaradhi, K. (Andhra Univ., Waltair, India). J. Appl. Phys., 39: 1407-10(Feb. 15, 1968).

Experimental gamma-ray cross sections in the energy region 145 to 662 keV, in the elements Al, Cu, and Pb are evolved utilizing most of the available experimental data with suitable errors attached to them on a statistical basis. Agreement is observed with the theoretical total gamma-ray cross sections within the range of errors. With these values using the "subtraction technique," studies are made on (a) photoelectric cross sections, (b) scattering cross sections, and (c) S(q,Z) function. Within the range of errors, agreement is observed between theory and experiment, deferring the existing discrepancies in this region and in these elements. A systematic measurement of total gamma-ray cross sections is suggested, so that there should be repeatability of the experimental results by any experimenter within the range of specified accuracy to draw better conclusions on the existing discrepancies between theory and experiment in the region and in these elements. (auth)

22197 ANGULAR DISTRIBUTION OF THE γ DOSE RATE BEHIND GRAPHITE SHIELDING FROM A SOURCE WITH INITIAL ENERGY OF 4.45 MeV. Zolotukhin, V. G.; Efimenko, B. A.; Matusevich, E. S.; Omarov, S. S. At. Energ. (USSR), 24: 75-6 (Jan. 1968). (In Russian).

The angular dose distribution of γ radiation emitted from graphite block with a Po–Be alpha source distributed inside was measured using an isotropic-dose scintillation γ detector with neutron discrimination by de-excitation time. Inelastic neutron scattering in graphite revealed γ quanta of 4.43 MeV, identical to the energy of γ quanta in the source. The γ quanta from inelastic scattering comprised 30% of the total number of γ quanta in the source. The contribution of soft γ quanta to the dose behind the shielding did not exceed 7, 4.5, and 3% of the total dose at 20, 40, and 50 cm, respectively. Graphical data are given for the angular distribution of γ doses at the boundary of the semi-infinite graphite media for a plane isotropic 4.43-MeV γ source distributed at different distances d from the boundary of the medium. (R.V.J.)

22198 VALIDITY OF THE STRAIGHTAHEAD APPROXIMATION IN SPACE-VEHICLE SHIELDING STUDIES. PART II. Alsmiller, R. G. Jr.; Irving, D. C.; Moran, H. S. (Oak Ridge National Lab., Tenn.). Nucl. Sci. Eng., 32: 56-61(Apr. 1968). (ORNL-P-3371).

The straightahead approximation, i.e., the approximation that the secondary particles from nucleon–nucleus collisions are emitted in the direction of the incident nucleon, is often used in space-vehicle shielding studies. The validity of this approximation has been tested by comparing calculations made with the angular distribution of secondary particles properly taken into account with calculations using the approximation. Comparisons between the calculations are given for both monoenergetic protons and a typical flare spectrum normally incident on slab shields followed by tissue. The results indicate that the approximation is sufficiently accurate to justify its use in obtaining estimates of the secondary-particle contribution to the dose behind thin shields. (auth)

Solid-State Physics

Refer also to abstracts 21721, 21866, 21867, 22267, 22520, and 22611.

22199 (COO-1105-128) STARK EFFECT IN COLOR CENTERS OF ALKALI HALIDES. Rhyner, Charles R. (Wisconsin Univ., Madison). 1967. Contract AT(11-1)-1105. 71p. Dep. CFSTI.

Thesis.

The Stark effect of the F center in NaCl, NaBr, KCl, KBr, KI, and RbCl, the M center in KCl, and the Z_1 center in KCl:Sr was measured using an ac electric field. The fractional change of the absorption coefficient, $\Delta\alpha/\alpha$, at the peak of the F band, normalized to a Lorentz local field of 200 kV/cm, was found to be approximately 2×10^{-5} for NaCl and NaBr, 11×10^{-5} for RbCl, and 17×10^{-5} for KCl, KBr, and KI. A simple continuum model is presented which qualitatively relates the effect to the nearest-neighbor separation and an effective dielectric constant. The Stark effect at the peak of the M band in KCl was $3.9 \pm 0.4 \times 10^{-4}$ for an applied electric field of 97 kV/cm. A measurement of the change in the absorption coefficient, $\Delta\alpha$, versus photon energy produced a nonsymmetrical curve. This indicates that the effect observed was not the linear Stark effect and thus provides additional evidence that Seitz's model is incorrect. The absorption coefficient increased at energies lower than the M band corresponding to a decrease in the absorption coefficient of the M band. The effect is attributed to the mixing of two nondegenerate energy levels of opposite parity. The optical transition to the level of lower energy is normally forbidden. The Z_1 center in KCl:Sr did not exhibit a detectable Stark effect. It was determined, however, that $\Delta\alpha/\alpha < 8 \times 10^{-6}$ for an applied electric field of 97 kV/cm. If the Z_1 possesses a permanent dipole moment, the difference between the expectation values of dipole moment in the ground state and excited state is less than 1.0×10^{-28} cgs unit. (auth)

22200 (NYO-2962-6) THE INTERACTION OF RADIATION WITH MATTER. Progress Report. (New York Univ., N. Y. Radiation and Solid State Lab.). Dec. 1967. Contract AT(30-1)-2962. 78p. Dep. CFSTI.

Separate abstracts were prepared for five sections of the report. The remaining sections summarize very briefly current studies on energy transfer and ionization processes in organic and inorganic materials and on basic processes triggered when a heavy ion penetrates matter. (A.G.W.)

For abstracts of individual sections see: 21843–21845, 22201, and 22202.

22201 (NYO-2962-6, pp 36-53) CHANNELING STUDIES THROUGH CHARACTERISTIC RADIATIONS. Brandt, W.; Dobrin, R.; Jack, H. Jr.; Laubert, R.; Roth, S. (New York Univ., N. Y. Radiation and Solid State Lab.).

The yield of K-shell fluorescence radiation emitted from aluminum crystals is measured during bombardment with H^+, $^3He^+$, $^4He^+$ and $^{20}Ne^+$ ions in the energy range 100 to 200 keV under channeling conditions. The yield as a function of the angle between the beam and a crystallographic direction shows a minimum; the half width is independent of the ion mass and varies as the square root of the incident charge. Under proton bombardment the yield curve for copper K-shell excitation is somewhat wider than for L-shell excitation. The difference diminishes with increasing energy and vanishes near the upper end of our energy range. Channeling in organic crystals is demonstrated along the c direction of thin

anthracene crystals in penetration experiments with 5.5-MeV alphas. The yield of optical fluorescence radiation emitted from the anthracene target during alpha bombardment shows a minimum when particles are incident along this channeling direction. (auth)

22202 (NYO-2962-6, pp 55-62) HEAVY PARTICLES IN SEMICONDUCTOR DETECTORS. Karcher, T.; Wotherspoon, N. (New York Univ., N. Y. Radiation and Solid State Lab.).

When a charged particle is stopped by a surface barrier detector, part of its energy is expended in electronic excitations of the Si crystal and part is lost in nuclear displacements. Calculations were made on the relation between particle energy, electronic excitation, and nuclear displacement using Lindhard's equations and modifications of the equations. Results are shown for Si ions and protons on Si. Experimental results for protons on Si did not agree with the calculations. (A.G.W.)

22203 (ORNL-4250) SOLID STATE DIVISION ANNUAL PROGRESS REPORT FOR PERIOD ENDING DECEMBER 31, 1967. (Oak Ridge National Lab., Tenn.). Mar. 1968. Contract W-7405-eng-26. 130p. Dep. CFSTI.

Brief summaries of work on projects in the following fields are presented: lattice dynamics, magnetic properties, electron spin resonance, electronic and optical properties, low-temperature properties, radiation damage, channeling, dislocations and radiation effects on plastic deformation and fracture, surface studies and anomalous x-ray transmission, research materials, and experimental facilities. Many of the summaries are abstracts of papers published, to be published, or presented at meetings. A list of publications is included. (A.G.W.)

22204 (ORO-2755-20) SURFACE PROPERTIES OF MAGNETIC MATERIALS. Progress Report No. 8, March 1, 1967-February 29, 1968. Scheibner, E. J. (Georgia Inst. of Tech., Atlanta. Engineering Experiment Station). Feb. 29, 1968. Contract AT(40-1)-2755. 88p. Dep. CFSTI.

Experimental and theoretical investigations of electron interaction mechanisms in solids and the related physical and chemical properties of solid surfaces are summarized. The dielectric theory of energy losses for slow electrons in solids and a perturbation treatment of single-electron excitations are discussed. Data on characteristic energy losses in Cu and Ni and interpreted in terms of many-particle collective excitations and single-particle interband transitions. An apparatus for determining optical constants, compatible with the LEED system, is described, and the theoretical correlation of optical data with electron energy-loss measurements is explored. Data on the energy distributions of secondary electrons emitted from clean and oxygen-covered Cu surfaces by primary electrons are presented and interpreted on the basis of Auger neutralization of ions at the surface. A summary of theoretical calculations related to the true secondary energy distributions and a discussion of data from graphite and silicon are included. (A.G.W.)

22205 (AERE-Trans-1089) CORRECTIONS TO THE CASCADE THEORY OF DEFECT PRODUCTION. Diener, G.; Heinrich, D.; Lenk, R. Translated by J. B. Sykes (Atomic Energy Research Establishment, Harwell, Eng.), from Phys. Status Solidi, 3: 2069-82(1963). 16p. Dep. CFSTI. UK 2s. 6d. JCL $1.60 fs, $0.80 mf.

An approximate solution of the integral equation of cascade theory is obtained by the introduction of an equivalent collision distribution, for conditions in which the original collision distribution does not permit an exact solution. The method is applied to the 1/T collision distribution, and the influence of collision chains on the defect concentration estimated for [110] chains in copper. This calculation gives a reduction in the defect concentration of about 7%. The effect of a change in the atomic interaction potential on this correction is discussed. (auth)

22206 (AERE-Trans-1090) CASCADE THEORY OF DEFECT PRODUCTION. Heinrich, D.; Lenk, R. Translated by J. B. Sykes (Atomic Energy Research Establishment, Harwell, Eng.), from Phys. Status Solidi, 3: 676-91(1963). 23p. Dep. CFSTI. UK 3s. 6d. JCL $2.60 fs, $1.10 mf.

The basic assumptions of cascade theory are discussed and a very general angular-dependent formulation of this theory is developed, which contains, apart from the threshold energy, a further energy parameter. Angular integration then gives the continuous displacement probability. This general model contains, as special cases, most of the models discussed by other authors, and therefore interpolation is possible. The general continuous displacement probability can be reduced mathematically to give a sharp threshold energy. This procedure is quite general and allows a physical interpretation. As a test case the hard-core approximation for the scattering law was applied to the present theory. (auth)

22207 MONOPHONON SCATTERING OF SLOW NEUTRONS IN DISORDERED SOLID SOLUTIONS. Koval'chuk, V. G. (Kiev Inst. of Physics). Ukr. Fiz. Zh., 13: 294-303(Feb. 1968). (In Russian).

By means of Green's functions averaged according to impurity configurations expressions for the scattering cross section of slow neutrons in a crystal with impurity are obtained. (auth)

22208 ELECTRON SPIN RESONANCE IN γ-IRRADIATED GLYCINE AND TRIGLYCINE SULFATE SINGLE CRYSTALS. Shul'ga, S. Z. (Kiev Inst. of Physics). Ukr. Fiz. Zh., 13: 211-14(Feb. 1968). (In Russian).

The ESR spectra were investigated of free radicals formed in γ-irradiated glycine and triglycine sulfate single crystals in the temperature range 77 to 293°K and at different levels of the microwave power. The comparison of the data obtained showed that the main products of γ radiolysis in both glycine and triglycine sulfate are the same. A probable structure of a nitrogen-containing radical is $NH_3^+\dot{C}HCO_2^-$. (auth)

22209 ABSORPTION EDGE OF GERMANIUM EXPOSED TO FAST ELECTRON RADIATION. Gerasimov, A. B.; Rogachev, A. A.; Eristavi, G. L. (Ioffe Inst. of Physics and Tech., Leningrad). Fiz. Tekh. Poluprov., 1: 1582-4(1967). (In Russian).

An experimental investigation was made at room temperature of the edges of direct optical transitions in germanium under the impact of 5-MeV electrons. Specimens (plane-parallel plates from 10 to 100 μ thick) doped with antimony at concentrations of 10^{15} to 2×10^{18} per cm^3 were subjected to varying doses of radiation. It was found that the effect of the radiation on the shape of the absorption edge depends substantially on the antimony content of the specimens. The edge form of a "pure" specimen did not show any discernible change even under the highest (1.2×10^{19} per cm^2) radiation doses. In doped specimens, the effect of irradiation grew as the antimony content increased. The irradiation in general resulted in a pronounced diffusion of the absorption edge, which can be explained by the formation of a band tail as the result of the washing-out of the band edges by the potential fluctuations stemming from the concentration fluctuations of charged impurity centers. The speed of formation of charged defects in heavily doped specimens was two orders higher than in pure specimens. A quantitative analysis is considered impossible at the present time since the extent of the "frozen" screening connected with the charged centers is unknown. (ATD)

22210 SHOCK COMPRESSION OF FOAMED GRAPHITE. Boade, R. R. (Sandia Lab., Albuquerque, N. Mex.). J. Appl. Phys., 39: 1609-17(Feb. 15, 1968).

Conventional high-explosive techniques have been used to determine the principal Hugoniots of two graphite foams for stresses up to about 190 kbar. The initial densities of the foams were 0.55 and 0.68 gm/cm^3. Hugoniot data for each foam fall into two distinct domains, depending on the amplitude of the input shock wave. Continuous free-surface velocity measurements on the foam surfaces indicate that shock waves in the lower stress domains have two-wave structures. The inherent irregularity of the surfaces of the foams, however, prevented exact measurement of the properties of these two-wave structures. Results of further experiments which were designed to study loading and unloading from shocked states in the foam are consistent with the two-wave picture in the lower stress domains and also show that single shock waves exist in the higher stress domains. Data in the higher stress domains show an increase in specific volume with increasing stress. This "bending back" of the Hugoniot is attributed to increases in thermal energy which occur in the compression process. Estimates of Grüneisen's parameter have been made for the higher stress domains, where voidless states are believed to exist. The values obtained for Grüneisen's parameter as well as the general behavior of the Hugoniots suggest that the graphite-to-diamond phase transition occurs at the higher stresses. (auth)

22211 EFFECTS OF ANNEALING AND IRRADIATION ON THE STACKING-FAULT ENERGY OF Cu-Al SOLID SOLUTIONS. Kamada, Koji (Japan Atomic Energy Research Inst., Tokyo). J. Appl. Phys., 39: 1824-8(Feb. 15, 1968).

Annealing and irradiation effects of the stacking-fault energies of Cu-Al were observed by measuring the curvatures and dimensions of dislocation nodes with an electron microscope. For Cu-10 at.% Al alloy, the expansion of the dislocation nodes was observed on annealing at 150°C. For Cu-14 at.% Al alloy, the annealing at 150°C does not produce any detectable change in the dislocation nodes. For this alloy, the nodes contract on annealing at 300°C and the subsequent electron irradiation at room temperature produces the expansion of the nodes. These annealing and subsequent irradiation effects are due to the departure of the already segregated solute atoms and their resegregation. Slipping

on the (111) plane due to the recovery of dislocation networks at 400°C annealing is also observed. (auth)

22212 EFFECTS OF RADIATION-INDUCED CROSS-LINKS ON THE LOW-TEMPERATURE THERMAL PROPERTIES OF POLYSTYRENE. Reese, W.; Higgins, P. J.; Rostine, G. W. (Naval Postgraduate School, Monterey, Calif.). J. Appl. Phys., 39: 1800-2(Feb. 15, 1968).

Measurements of the thermal conductivity and heat capacity in the liquid-helium temperature range of polystyrene which was cross linked by exposure to an 80-MeV electron beam are reported. The measurements were performed over a range of cross-linking coefficient from 0 to 12. No significant change in the thermal conductivity was observed, but about a 25% reduction in the heat capacity occurred. The thermal conductivity results are compatible with the existing theory of the thermal conductivity of amorphous polymers, while the heat capacity result is taken to indicate a significant reduction in the "excess heat capacity" associated with nonacoustic, low-frequency modes. (auth)

22213 PADE APPROXIMANT ESTIMATES OF THE MAGNETIC PROPERTIES OF EuO AND EuS. Patterson, J. D.; Chen, Peter C. Y.; Broz, Alfred L. (South Dakota School of Mines and Tech., Rapid City). J. Appl. Phys., 39: 1629-33(Feb. 15, 1968).

A Padé approximant analysis has been made of the magnetic susceptibility (X) and magnetic specific heat (C_m) of EuS. A similar, less detailed, calculation has been made on EuO. All calculations are limited in accuracy because only a few terms are known in the appropriate power series. Our calculations indicate that the Curie temperature (T_c) for EuS appears to be in the range 14.5° to 16.0°K with $\gamma \simeq 1.4$, where γ is defined by $X \rightarrow (T - T_c)^{-\gamma}$ as $T \rightarrow T_c^+$). T_c for EuO appears to be in the range of 60° to 70°K with $\gamma \simeq 1.4$. In our calculations for EuS, the exchange integrals of Charap and Boyd ($J_1/k = 0.20$°K and $J_2/k = -0.08$°K) were used. For EuO, the exchange integrals $J_1/k = 0.65$°K and $J_2/k = -0.05$°K were used. Our results indicate that the exchange integrals of Charap and Boyd can be improved upon. In particular, the set proposed by Passenheim et al. ($J_1/k = 0.20$°K and $J_2/k = -0.06$°K) appears to be better. Similar comments are true for EuO. It appears that the Curie temperature predicted by the Padé approximant method provides at least one rather sensitive test for any proposed set of two exchange integrals. (auth)

22214 CALCULATIONS OF ELECTRON-RADIATION DAMAGE RATE AS A FUNCTION OF DEPTH IN SILICON. Stevens, P. R. C. (United Kingdom Atomic Energy Authority, Aldermaston, Eng.). J. Appl. Phys., 39: 1561-3(Feb. 15, 1968).

The distribution of electron-radiation damage defects with depth has been calculated from recent measurements of electron angular dispersion and energy loss in silicon combined with experimental measurements of damage rate as a function of electron energy. The results of the calculation are shown to be substantially in agreement with the experimental results of Hitchcock. (auth)

22215 INVESTIGATION OF FAST-NEUTRON RADIATION DAMAGE IN NEARLY PERFECT COPPER CRYSTALS BY X-RAY DIFFRACTION TECHNIQUES. Baldwin, T. O.; Sherrill, F. A.; Young, F. W. Jr. (Oak Ridge National Lab., Tenn.). J. Appl. Phys., 39: 1541-50(Feb. 15, 1968).

The effects of fast-neutron irradiation at about 40°C in nearly perfect copper crystals have been examined by x-ray diffraction techniques. Anomalous x-ray transmission (Borrmann) and Bragg reflection geometries were used to investigate the changes in diffracted intensities caused by defects produced by the neutron irradiation. Both Borrmann and Bragg peak intensities were reduced to values significantly below those for perfect crystals, and the reduction in the Bragg intensities was accompanied by a large increase in the diffuse scattering in the wings of the peak. It is shown that isolated point defects and the distortion associated with them would not account for the changes in x-ray intensities. Annealing studies indicated that both vacancies and interstitials were present in these crystals after irradiation, and all of the damage was removed by annealing at 500°C. (auth)

22216 MAGNETIC AND ELECTRICAL PROPERTIES OF SOME Yb–Sb PHASES. Bodnar, R. E.; Steinfink, H.; Narasimhan, K. S. V. L. (Univ. of Texas, Austin). J. Appl. Phys., 39: 1485-9(Feb. 15, 1968).

The magnetic susceptibilities and electrical and thermoelectric behavior of $YbSb_2$, YbSb, α-Yb_3Sb_4, β-Yb_3Sb_4, Yb_4Sb_3, Yb_5Sb_3, and Yb_3Sb_2 were investigated. The compounds YbSb and Yb_3Sb_4 have considerable trivalent ytterbium present; 0.89 and 0.26 electrons, respectively, have been removed from the 4f shell. The other phases are essentially diamagnetic and behave similarly to ytterbium metal. The resistivity of the phases containing trivalent ions is enhanced because of the possibility of s–f scattering. Yb_3Sb_2 is weakly paramagnetic, but has the highest resistivity because its crystal structure appears to have partially occupied ytterbium sites. (auth)

22217 CONNECTION BETWEEN DYNAMIC POLARIZATION OF NUCLEI AND ELECTRON SPIN–SPIN RESERVOIR TEMPERATURE. Atsarkin, V. A.; Mefed, A. E.; Rodak, M. I. (Inst. of Radio Engineering and Electronics, USSR). JETP Lett. (USSR) (Engl. Transl.), 6: 359-62(Dec. 1, 1967).

Translated from Zh. Eksp. Teor. Fiz., Pis'ma Redaktsiyu, 6: 942-5(Dec. 1, 1967).

A study was made to obtain proof of a direct coupling between the S–S and Z_N systems and to show that this coupling produces dynamic polarization of the nuclei. (M.O.W.)

22218 THE HYPERFINE STRUCTURE OF ^{161}Dy IN DYSPROSIUM SALTS. Wickman, H. H.; Nowik, I. (Bell Telephone Labs., Inc., Murray Hill, N. J.). J. Phys. Chem. Solids, 28: 2099-2103 (Oct. 1967).

The Moessbauer technique was used to investigate the low-temperature (4.2°K) hyperfine structure of ^{161}Dy in two groups of paramagnetic salts: (1) Dy oxalate, Dy acetate, $DyF_3 \cdot 5H_2O$, $Dy(NO_3)_3 \cdot 6H_2O$, $DyPO_4 \cdot 5H_2O$, $Dy(MoO_4)_3$, $DyFeO_3$, $DyMn_2O_5$, DyAlG; and (2) Dy_2O_3, $DyCl_3 \cdot 6H_2O$, Dy ethyl sulfate. In all cases the observed spectra were consistent with a collinear hyperfine magnetic field and axially symmetric EFG. This requires a ground doublet with the property $g_\perp = 0 \neq g_\parallel$. In group-1 compounds the observed hfs interactions were within 4 per cent of the free ion hyperfine interaction, $g_e\beta_N H_{eff} = 820 \pm 20$ Mc for a doublet $|\pm J_z\rangle$ with $J_z = 15/2$. The three compounds in group 2 had $g_e\beta_N H_{eff} =$ 727, 675, and 446 Mc respectively. The results in group 1 imply a ground doublet with $g_\parallel \simeq 19.6$, and in group 2 values for $g_\parallel$ of 17.2, 16.0, and 10.6 for the three compounds, respectively. (auth)

22219 PARAMAGNETIC RESONANCE OF COPPER ATOMS STABILIZED IN ALKALI METAL HALIDE CRYSTALS. Zhitnikov, R. A.; Koltsov, V. B.; Melnikov, N. I. (Ioffe Physico-Technical Inst., Leningrad). Phys. Status Solidi, 26: 371-80(Mar. 1, 1968).

Stabilized copper atoms are obtained at 77°K by irradiating alkali metal halide crystals (LiCl, NaCl, and KCl) containing monovalent copper ions with x rays. The properties of these stabilized atoms are studied by PR (paramagnetic resonance). In the paramagnetic resonance spectra a superhyperfine structure is observed indicating a substitutional position of the stabilized copper atoms in the cubic lattice of the alkali halide crystals. An interpretation of the data obtained is given. (auth)

22220 RECRYSTALLIZATION OF COLD-WORKED GOLD DURING α IRRADIATION. Beyer, H.; Sizmann, R. (Technische Hochschule, Munich. Univ., Munich). Phys. Status Solidi, 26: 359-70(Mar. 1, 1968).

The recrystallization of gold is investigated by electrical-resistivity measurements and checked with photomicrographs. The influence of irradiation with 4-MeV α particles at different temperatures and flux densities is studied. Between 100 and 150°C the recrystallization of Au (purity 99.96%) is enhanced during irradiation. With increasing irradiation dose the enhanced reaction rate is overcompensated by a strong retardation of the grain growth. The enhancement is attributed to radiation-induced diffusion, the retardation to barrier pinning of dislocations and grain boundaries. (auth)

22221 THERMALLY ACTIVATED DISLOCATION MOTION IN A SOLID CONTAINING A MULTIPLE SPECTRUM OF DISLOCATION OBSTACLES. Frank, W. (Max-Planck-Institut fuer Metallforschung, Stuttgart. Univ., Stuttgart). Phys. Status Solidi, 26: 197-206(Mar. 1, 1968).

A theoretical treatment is given of the thermally activated motion of dislocations in the presence of dislocation obstacles with different hardness. The hardness of an obstacle is allowed to depend on an arbitrary number of characteristic parameters (multiple obstacle spectrum). It is shown that even under these conditions the slip rate $\dot{a}$ obeys an Arrhenius equation $\dot{a} = \dot{a}_0 e^{-\overline{\Delta G}/kT}$, where $\dot{a}_0$ = constant and $\overline{\Delta G}$ = mean free activation enthalpy. The general theory is applied to the case of plastic flow in neutron-irradiated copper. In this case the dislocation obstacles are vacancy dislocation loops of different sizes, different orientations, and different distances from the slip planes of the mobile dislocations (triple spectrum). (auth)

22222 HIGH MAGNETIC FIELDS AND NUCLEAR COOLING. Kurti, N. (Clarendon Lab., Oxford). pp 31-9 of Les Champs Magnetiques Intenses, leur Production et leurs Applications. Paris, Centre National de la Recherche Scientifique, 1967.

From International Colloquium on Intense Magnetic Fields,

their Production and their Applications, Grenoble, France. See CONF-660921.

After a comparison of the relative speeds of development of ordinary magnetic cooling and of nuclear cooling, the paper discusses the importance of using high magnetic fields in nuclear cooling experiments designed to study the properties of the spin-system only. The conditions for cooling the conduction electrons in a metal by nuclear demagnetization are considered next and it is shown that by using metals with short relaxation times, e.g., Tl, it should be possible to cool electrons to somewhat below 10^{-5}°K. Computed values of the cooling power of the nuclear spins for various conduction electron temperatures are also given. Finally, attempts to cool conduction electrons are described and possible reasons for the disappointing results are discussed. (auth)

22223 INTENSE MAGNETIC FIELDS IN PHYSICS OF SOLIDS AT VERY LOW TEMPERATURES. Weil, L. (CNRS, Grenoble, France). pp 41-50 of Les Champs Magnetiques Intenses, leur Production et leurs Applications. Paris, Centre National de la Recherche Scientifique, 1967. (In French).

From International Colloquium on Intense Magnetic Fields, their Production and their Applications, Grenoble, France. See CONF-660921.

The application of intense magnetic fields to solid-state physics at very low temperatures is discussed. This is done by making reference to recent results in the areas of electronic magnetism, nuclear magnetism, Fermi surfaces of metals, semiconductors, magnon, phonon and electron interactions, and superconductivity. (auth)

22224 APPLICATION OF INTENSE CONTINUOUS MAGNETIC FIELDS TO THE STUDY OF ANTIFERRO–FERROMAGNETIC TRANSITIONS AND OF THEIR FERROMAGNETIC INTERACTIONS IN DILUTE ALLOYS OF IRON IN GOLD. Henry, W. E. (Lockheed Missiles and Space Co., Sunnyvale, Calif.). pp 151-67 of Les Champs Magnetiques Intenses, leur Production et leurs Applications. Paris, Centre National de la Recherche Scientifique, 1967. (In French).

From International Colloquium on Intense Magnetic Fields, their Production and their Applications, Grenoble, France. See CONF-660921.

The existence of a special installation for the production of continuous high magnetic fields permits the carrying out of research which would otherwise be impossible. Research is described relating to ferromagnetic, antiferromagnetic and metamagnetic interactions. Metamagnetic substances are of interest because they provide a means of studying the atomic structure of exchange interactions. Some high field studies have been made on $Mn_{2-x}SbCr_x$, holmium–indium and europium. Under the influence of field, transition temperatures (antiferromagnetic to ferromagnetic) are displaced toward elevated temperatures; the ferromagnetic range is expanded. For europium, at 4.2°K, the field necessary to induce the second rapid increase of the magnetization is about 40,000 gauss and the saturation is approached at about 111,000 gauss. For $Mn_{2-x}SbCr_x$ which presents the antiferromagnetic state at lower temperatures than the ferromagnetic state, the transition temperature is lowered as the applied field is increased; for the concentration, x = 0.06, the transition is at 260°K under 30,000 gauss, 255°K in a field of 40,000 gauss, 240°K under 85,000 gauss and 230°K under 95,000 gauss. These transitions are discussed in terms of the theories of Néel and of Kittel. The study of the magnetization of alloys, $Au_{1-x}Fe_x$ (x = 0.02, 0.05 and 0.08) embraces the coercive force, symmetry of the hysteresis cycle, and the remanence at various temperatures, hydrogen and helium temperatures included. At 295°K, the magnetization is linear in magnetic field; neither sample shows any remanence; at 77.4°K, no remanence occurs; at 20.4°K, no remanence appears for the sample where x = 0.02, but on the contrary, remanence is observed for the sample, x = 0.08. The sample with x = 0.02 does show a remanence equal to 1% of the magnetization under 95,000 gauss at 4.2°K and shows a remanence 2% of the magnetization (high field) at 1.5°K. The sample with x = 0.08 shows a remanence equal to 20% of its magnetization at 1.5°K under 95,000 gauss. The magnetizations are compared under fields intense as a function of temperature and of concentration of iron. The results (experimental) show that it is difficult to explain the magnetic properties with the theory that there are clumps of iron in the material. The concentrations of iron are lower than the threshold concentrations of iron necessary for a ferromagnetic transition on the basis of localized (bound) electrons. Nevertheless, these results may be explained by taking into account the role of the itinerant (free) electrons. (auth)

22225 PULSED MAGNETIC FIELDS APPLIED TO THE INVESTIGATION OF MAGNETIC PROPERTIES OF SOME RARE EARTH COMPOUND. Busch, G.; Vogt, O.; Schwob, P. (Laboratorium fuer Festkorperphysik, ETH, Zurich). pp 401-7 of Les Champs Magnetiques Intenses, leur Production et leurs Applications. Paris, Centre National de la Recherche Scientifique, 1967.

From International Colloquium on Intense Magnetic Fields, their Production and their Applications, Grenoble, France. See CONF-660921.

Magnetic fields up to 200 kOe are produced by discharging a capacitor bank through a solenoid. Magnetization and magnetic field are measured simultaneously by means of suitably located pickup coils. It is also possible to measure magnetic properties as a function of hydrostatic pressure or sample orientation. The interest is focused on the rare earth compounds where, depending on the specific substance, anisotropy, exchange, and external field can predominate. (auth)

22226 APPLICATION OF PULSE MAGNETIC FIELD TO MAGNETO-OPTICAL STUDIES IN SEMICONDUCTORS. Nishina, Y. (Tohoku Univ., Sendai); Kurita, S.; Sugano, S. pp 417-22 of Les Champs Magnetiques Intenses, leur Production et leurs Applications. Paris, Centre National de la Recherche Scientifique, 1967.

From International Colloquium on Intense Magnetic Fields, their Production and their Applications, Grenoble, France. See CONF-660921.

An experimental method is described for measuring the magneto-absorption and the Faraday rotation simultaneously in a single sweep of a pulsed magnetic field. A Bitter-type solenoid made of 100 sheets of copper plates produced the field of 260 kG at the center of its axial bore of 14 mm in diameter when the 2,000-μF condenser bank was charged to 2,100 V and was discharged through the solenoid. A thin plate of the semiconductor sample was sandwiched between a pair of polaroid sheets which were oriented at 45° with respect to each other. A pair of quartz optical pipes were used for minimizing the disturbance from the bubbling of the liquid nitrogen, where the magnet with the sample was immersed. The interband magneto-optical effects in GaSe were measured as an example for the use of the above technique. (auth)

22227 EFFECTS OF HIGH MAGNETIC FIELDS ON IMPURITY CONDUCTION IN n-GERMANIUM. Shogenji, Kisaburo; Maeda, Seijiro (Hitachi Ltd., Tokyo). pp 423-7 of Les Champs Magnetiques Intenses, leur Production et leurs Applications. Paris, Centre National de la Recherche Scientifique, 1967.

From International Colloquium on Intense Magnetic Fields, their Production and their Applications, Grenoble, France. See CONF-660921.

Impurity conduction of n-type germanium at high magnetic fields has been investigated. A steady field magnet was used. Its power source consists of a motor-generator set (3,200 kVA, 200 Hz), transformers and silicon rectifiers. The Bitter-type solenoid which has available space of 60-mm diameter is able to produce the maximum field of 100 kG at 280 V, 11.3 kA. Cooling of the solenoid is performed using deionized water. Resistivity and Hall coefficient of Sb-doped germanium have been measured by means of the usual dc method at the helium temperatures. Resistivity increases in proportion to exp H at high magnetic fields. By applying a high magnetic field, the characteristics of metallic impurity conduction can be changed into those with two activation energies. These activation energies are not considered to correspond to the usual activation energies ϵ_2 and ϵ_3 in the case of impurity conduction. Probably one of them is due to the Zeeman splitting of the ground level of the impurity. (auth)

22228 MOESSBAUER EFFECT IN TIN COMPOUNDS: INTERPRETATION OF ISOMER SHIFTS AND DETERMINATION OF THE NUCLEAR RADIUS CHANGE IN ^{119}Sn. Lees, Joseph K.; Flinn, Paul A. (Carnegie-Mellon Univ., Pittsburgh). J. Chem. Phys., 48: 882-9(Jan. 15, 1968).

An interpretation of the isomer shift of ^{119m}Sn in its two ionic states [(2+) and (4+)] and its one covalent (sp^3) state is presented. Based on the values of the isomer shifts of the ideal configuration of +2.86 mm/sec for Sn(2+), –2.36 mm/sec for Sn(4+), and –0.075 mm/sec for Sn(sp^3) all relative to Mg_2Sn (77°K) and a Liberman–Waber–Cromer relativistic wave-function calculation, a value of $\delta R/R = +9.21 \times 10^{-5}$ is obtained. In addition, a calibration for the corresponding shift due to a single 5s electron, 3.06 mm/sec, the 5s–5s screening effects, –0.20 mm/sec, the 5s–5p screening effects, –0.09 mm/sec, and the inner-shell screening due to the 5s electron, –0.05 mm/sec is given. (auth)

22229 NUCLEAR MAGNETIC RESONANCE IN 'CUBIC' INDIUM. Setty, D. L. Radhakrishna (Tata Inst. of Fundamental Research, Bombay). J. Phys. Soc. Jap., 24: 722-5(Apr. 1968).

Indium alloyed with 4.5 to 12.2 at. % cadmium can exist in cubic phase at and above 100°C. The Knight shift of the ^{115}In resonance in cubic phase at each of the concentrations 5, 8, and 11 at. % of cadmium has been determined and extrapolated to zero concentration of cadmium. The value has been found to be +0.83 ± 0.02%.

The results have been discussed in the light of the free electron Fermi surface in indium metal. (auth)

22230 KINETIC MODEL SIMULATING RADIATIVE CENTER IN SILICON. Makarevich, A. I.; Raines, L. Yu. (Inst. of Physics of Solids and Semiconductors, Minsk). Dokl. Akad. Nauk BSSR, 11: 1072-5(Dec. 1967). (In Russian).

A kinetic model of predominant changes in silicon electric properties induced by radiation is described, and a system of linear differential equations was developed. The quantitative coincidence of theoretical and experimental curves of the rate of E center appearance as a function of radiation dose was obtained. (R.V.J.)

22231 INFLUENCE OF LIGHT ON THE LOW-TEMPERATURE ANNEALING OF RADIATION DEFECTS IN GERMANIUM. Gerasimov, A. B.; Dolidze, N. D.; Kakhidze, N. G.; Konovalenko, B. M.; Chelidze, N. V. (Ioffe Inst. of Physics and Tech., Leningrad). Fiz. Tek. Poluprov., 1: 982-5(1967). (In Russian).

The influence of light on the annealing of radiation defects in germanium was measured in the temperature interval from 77 to 300°K, following isochronous annealing of germanium samples irradiated with 4-MeV electrons at 77°K. The samples were n-type with donor concentration 2×10^{14} to 2×10^{15} cm^{-3}, which were converted by the irradiation into p-type. The tests consisted of measuring the Hall constant and conductivity in darkness at 77°K and after illumination. It was found that, at temperatures up to ~210°K, changes in the carrier density resulting from annealing in light have an opposite sign compared to changes obtained by annealing in darkness. It is shown that both reversible and irreversible changes in the properties of the radiation defects occur when the samples are exposed to light after annealing at different temperatures. At temperatures from 213 to 300°K, annealing in darkness and under illumination produce qualitatively the same effect, except that annealing is more intense under illumination. It is shown that an important role is played in the irreversible and reversible processes by the charged state of the centers on which the radiation defects or their complexes are produced, inasmuch as the charge of the center is altered when exposed to electromagnetic radiation of a definite wavelength. (ATD)

22232 EFFECT OF INTER-BAND MIXING ON THE NUCLEAR MAGNETIC RESONANCE OF ^{119}Sn IN USn_3. Rao, V. Udaya Shankar; Vijayaraghavan, R. (Tata Inst. of Fundamental Research, Bombay). J. Phys. Chem. Solids, 29: 123-7 (1968).

The nuclear magnetic resonance of ^{119}Sn and the magnetic susceptibility were studied for the intermetallic compound USn_3 in the temperature range 100 to 400°K. A strong temperature dependence was found in the ^{119}Sn Knight shift and its variation with susceptibility is linear. The results were interpreted in terms of the admixture of the uranium 5f wavefunctions with the tin 5s wavefunctions. The effect of s–f exchange was considered. The contribution to the susceptibility from the Kubo–Obata paramagnetism of the 5f band was estimated. (auth) (UK)

22233 NMR STUDIES OF DIFFUSION IN GLASSY AND CRYSTALLINE LITHIUM BORATES. Bishop, S. G.; Bray, P. J. (Brown Univ., Providence). J. Chem. Phys., 48: 1709-17 (Feb. 15, 1968).

The ^7Li NMR spectra from several lithium borate glasses have been examined as a function of temperature and found to narrow abruptly with increasing temperature in the range of temperatures from 250 to 475°K. The observed narrowing is a manifestation of the phenomenon of motional narrowing, and is attributed to diffusion of the lithium ions in the glasses. Activation energies for this diffusion, as deduced from the temperature dependence of the ^7Li NMR linewidths, range from 0.22 eV in a glass containing 28.6 molar % Li_2O to 0.12 eV in a 60 molar % Li_2O glass. The ^{11}B NMR lines from these glasses are reduced somewhat with increasing temperature because of the removal of the lithium–boron dipolar interaction with the onset of the lithium diffusion. The linewidths of the ^7Li spectra from the crystalline lithium borates also decrease with increasing temperatures and the activation energies obtained from their narrowing rates range from 0.14 eV in the $Li_2O \cdot 4B_2O_3$ compound to 0.43 eV in the $3Li_2O \cdot 2B_2O_3$ compound. It has been concluded that the ionic movement responsible for the narrowing of the resonance spectra is motion within limited regions, rather than the movement over long distances necessary for electrical conductivity. (auth)

22234 SELF-TRAPPING OF RADIATION-PRODUCED ELECTRONS. Schiller, R. (Christie Hospital and Holt Radium Inst., Manchester, Eng.). Nature (London), 217: 1141-2(Mar. 23, 1968).

The trapping of free electrons produced by ionizing radiation in dielectric systems is discussed. Previous theoretical work in this field is briefly summarized, including the approach by the present author that in polar dielectrics escape of electrons from ions can be a free-energy-decreasing, and therefore spontaneous, process. The electrons that escape are treated as quasi-free, and the problem of the kinetics and mechanism of electron trapping arises. The theory, which has already received some experimental verification, uses a continuous dielectric medium to which the notion of any defect site is inapplicable. Stabilization of the electron in the medium as a self-trapping process is discussed, that is, the formation of an energy well in the medium under the influence of the electric field of the electron. The time needed for a free electron in a dielectric substance to form an energy well of suitable depth is discussed. (UK)

22235 MAGNETIC EQUATION OF STATE AND SPECIFIC HEAT OF EuS NEAR THE CURIE POINT. van der Hoeven, B. J. C. Jr.; Teaney, Dale T.; Moruzzi, V. L. (IBM Watson Research Center, Yorktown Heights, N. Y.). Phys. Rev. Lett., 20: 719-22(April 1, 1968).

The specific heat of EuS near the critical point is a homogeneous function of field and temperature. In zero field $\alpha = 0$ and $\alpha' = -0.25$, and along the critical isotherm the field variation is logarithmic. (auth)

22236 IRRADIATION-INDUCED LOW-TEMPERATURE VOLUME EXPANSION OF KCl AND KBr. Farnum, E. H.; Royce, B. S. H. (Princeton Univ., N. J.). Phys. Lett., 26A: 164-5(Jan. 15, 1968).

The macroscopic volume expansions caused by relaxations around Frenkel defects produced by x-irradiation at 80 and 6°K have been measured. For KCl and KBr the 80°K data give a relaxation for the F-center Frenkel pair of the order of that previously determined for F-center alone, indicating that the relaxation around the neutral interstitial is small. In contrast to this, the 6°K measurements indicate a relaxation around the negative ion interstitial of the same order as that associated with the α-center. (auth)

22237 MEASUREMENT OF THE OPTICAL CONSTANTS OF YTTRIUM OXIDE. Nigara, Yutaka (Tohoku Univ., Sendai, Japan). Jap. J. Appl. Phys., 7: 404-8(Apr. 1968).

By using a solar furnace, yttrium oxide crystals were grown by the fusion process. The crystals obtained were highly transparent in the spectral region from 0.25 to 9.6 μ. The refractive index in this region was measured by three different methods. The observed index values were well expressed by the dispersion formula. From the values of parameters in the formula, it was found that the center of the fundamental absorption and the lattice absorption were at about 0.139 and 22.9 μ, respectively. A brief discussion on the infrared and ultraviolet absorption edges is added. (auth)

22238 NMR SPIN DYNAMICS IN SOLIDS. I. ARTIFICIAL LINE NARROWING AND ZEEMAN SPIN–SPIN RELAXATION IN THE ROTATING FRAME. Mansfield, P.; Ware, D. (Univ. of Nottingham, Eng.). Phys. Rev., 168: 318-34(Apr. 10, 1968).

An experimental and theoretical study is made of the response of a single-magnetic-species spin system to a coherent train of resonant 90° rf pulses of spacing 2τ, following at time τ an initial preparatory 90° pulse. The rf phase of the coherent pulses is shifted 90° with respect to the initial pulse. It is shown that this pulse sequence will produce a sustained "solid-echo" chain for times much greater than T_2, i.e., approaching the spin–lattice relaxation time. This therefore shows promise as a new method of chemical-shift measurement in solids, as well as a direct method of measuring the rotating-frame spin–lattice relaxation time $T_{1\rho}$. Except for a small initial oscillation, the amplitudes of successive even or odd echo maxima in CaF_2 are found to decay exponentially with a time constant $T_{2\epsilon}$. It is shown theoretically that a simple diagonal assumption for the density matrix plus the rotational symmetry properties of the dipolar Hamiltonian to 90° pulses could explain the observed τ^{-3} dependence of $T_{2\epsilon}$ as well as the oscillatory effect. Numerical evaluation of the magnitude of $T_{2\epsilon}$ based on a cumulant-moment approximation gives good agreement with experiment. Further related experiments have been performed by spin-locking the ^{19}F magnetization in long pulses of low amplitude. These experiments are intended to simulate the multiple-pulse sequences by replacing the coherent-pulse train with its mean field. The results reveal considerable oscillatory effects due to mutual exchange of energy between the Zeeman and dipolar subsystems in the rotating reference frame. A theoretical analysis is given, which supports these effects. An estimate is made of the Zeeman dipolar cross-relaxation time, and is compared with Provotorov's theory as modified by Walstedt. In the multiple-pulse experiment, the "solid-echo" amplitude modulation may be ascribed to mutual energy exchange between the rf Zeeman energy in the zeroth Fourier harmonic of the pulse train (the mean pulse

field) and the dipolar energy. Because of the higher harmonics in the Fourier expansion, however, the initial oscillatory effects disappear as τ increases. (auth)

22239 SIGN DETERMINATION OF THE MAGNETIC HYPERFINE FIELD BY THE MOESSBAUER–FARADAY EFFECT. Gonser, U.; Housley, R. M. (North American Rockwell Corp., Thousand Oaks, Calif.). Phys. Lett., 26A: 157-8(Jan. 15, 1968).

The nuclear Faraday effect can be used in a zero velocity Moessbauer apparatus to determine the sign of the magnetic hyperfine field. (auth)

22240 SLOW-ELECTRON-INDUCED DEFECTS IN ALKALI METAL HALIDES. Townsend, P. D.; Kelly, J. C. (Univ. of Sussex, Eng.). Phys. Lett., 26A: 138-9(Jan. 15, 1968).

Low-energy electron bombardment of alkali metal halides produces color centers and sputtering. These processes have been considered in the light of various theories of defect formation. (auth)

22241 NUCLEAR-MAGNETIC-RESONANCE SINGLE-SHOT PASSAGE IN SOLIDS. Goldman, M.; Chapellier, M.; Chau, Vu Hoang (CEN, Saclay, Gif-sur-Yvette, France). Phys. Rev., 168: 301-8(Apr. 10, 1968).

The magnetization loss of a nuclear spin system irradiated with a rf field under a linear field sweep through the resonance is studied both theoretically and experimentally. Two limiting cases are considered. The first is that of a slightly saturating passage, in which the loss is simply related to the rf field amplitude, a fact that allows an easy calibration of the latter. The second case is that of a quasiadiabatic passage, which reverses the magnetization. Three factors contribute to the magnetization loss: (1) The passage is suddenly far in the wings of the line, and it becomes rather abruptly adiabatic at a given distance from resonance. An entropy increase accompanies this transition. (2) The passage through the central part is not quite adiabatic because of the finite sweep rate of the field through the line. (3) The finite spin–lattice relaxation time of the spin–spin term causes a loss of magnetization at the passage on the line. The losses are numerically computed for the fluorine spin system in CaF_2 with $H_0 \parallel [100]$, and they are found to agree with the experimental values. (auth)

22242 NUCLEAR MAGNETIC RESONANCE IN $DyAl_3$, $HoAl_3$, AND α-$ErAl_3$. Van Diepen, A. M. (Univ., Amsterdam); de Wijn, H. W.; Buschow, K. H. J. Phys. Lett., 26A: 340-1(Mar. 11, 1968).

The Knight shifts of the ^{27}Al NMR in $DyAl_3$, $HoAl_3$, and α-$ErAl_3$ have been measured at temperatures from 100 up to 420°K. Exchange constants J_{sf} between conduction electrons and 4f electrons are derived. (auth)

22243 THE COMPOUNDS $EuNi_5$, $TmNi_5$, AND $LuNi_5$ AND THEIR CRYSTAL STRUCTURE. Krypyakevich, P. I. (Lvov State Univ.). Dopov. Akad. Nauk Ukr. RSR, No. 6, 769-71(1966). (In Russian).

The crystal structure of $EuNi_5$, $TmNi_5$, and $LuNi_5$ is studied. The atomic radii of Tm and Lu are close to those of other rare earth metals in the yttrium group, which indicates that RNi_5 compounds with a $CaCu_5$ type structure might be found in the Tm–Ni and Lu–Ni systems. Since the atomic radius of Eu (2.02 A) is greater than that of any of the metals which form the RNi_5 compounds, the existence of $EuNi_5$ is also feasible. X-ray diffraction analysis proves the existence of the compounds $EuNi_5$, $TmNi_5$, and $LuNi_5$ with a $CaCu_5$ type structure. Comparison of the lattice constants for all RNi_5 compounds shows that the cerium atoms in $CeNi_5$ are in a tetravalent state, while the rare earth atoms for all the remaining compounds including those of Eu and Yb are in a trivalent state. (ATD)

22244 EFFECT OF DISSOLVING TERBIUM BY YTTRIUM ON THE HELICOIDAL STRUCTURE OF TERBIUM–YTTRIUM ALLOYS. Belov, K. P.; Levitin, R. Z.; Nikitin, S. A.; Solntseva, L. I. (Moscow State Univ.). Z. Eksp. Teor. Fiz., 54: 384-9 (Feb. 1968). (In Russian).

An interval of fields in which the helicoidal magnetic structure exists is determined from the measurements of the magnetic and magnetostrictional properties of terbium–yttrium alloys. It is found that when terbium is dissolved by yttrium, the transition temperature, helicoidal antiferromagnetism, and paramagnetism decrease while the energy gap separating the helicoidal and ferromagnetic structure sharply increases. (auth)

22245 NMR STUDY OF A LOCALIZED MOMENT: ^{51}V NMR IN DILUTE GOLD–VANADIUM ALLOYS. Narath, Albert (Sandia Corp., Albuquerque, N. Mex.); Gossard, A. C.; Wernick, J. H. Phys. Rev. Lett., 20: 795-8(Apr. 8, 1968).

The first observation of the NMR of a localized magnetic moment in a metal is reported at temperatures far below its Kondo temperature. The system studied is dilute solid solutions of vanadium (0.1 to 10 at. %) in gold. The partially spin-compensated d-spin magnetization of the impurities for the lowest concentration is detected, and evidence for interaction between the impurities at higher concentrations is gained. (auth)

22246 MOESSBAUER AND MAGNETIC PROPERTIES OF SEVERAL EUROPIUM INTERMETALLIC COMPOUNDS. Wickman, H. H.; Wernick, J. H.; Sherwood, R. C.; Wagner, C. F. (Bell Telephone Labs., Inc., Murray Hill, N. J.). J. Phys. Chem. Solids, 29: 181-2(Jan. 1968).

A number of Moessbauer EPR and NMR studies have shown that magnetic hyperfine fields in the range $290 \leq |H_{eff}| \leq 340$ kOe are observed in compounds of divalent europium with diamagnetic elements. This note reports additional studies of the magnetic properties, hyperfine fields, and/or isomer shifts in the intermetallics $EuZn_2$, $EuPt_2$, $EuPd_2$, $EuRh_2$ and $EuPd_3$. (UK)

22247 TRIGONAL WARPING OF THE BANDS AND HALL EFFECT IN GRAPHITE. Ono, Shusuke; Sugihara, Ko (Matsushita Electric Industrial Co., Ltd., Osaka). J. Phys. Soc. Jap., 24: 818-25(Apr. 1968).

By taking into account a band parameter γ_3 which characterizes the trigonal warping of the bands, the electric resistivity and Hall coefficient in graphite are calculated. Electron–phonon coupling constants determined so as to fit the observed resistivity well are $D_1 \doteq 27.9$ eV and $D_2 \doteq 0$, where D_1 and D_2 indicate the coupling constants related to the in-plane lattice vibration and out-of-plane mode, respectively. At room temperature effect of γ_3 on the calculated Hall coefficient is very small, while at low temperatures (25 to 50°K) it affects considerably. Calculated values at low temperatures are improved to a certain extent in consideration of γ_3, but they have opposite sign to the observed coefficients. This discrepancy is removed by introduction of carrier-carrier scattering effect. (auth)

22248 THERMOLUMINESCENCE AND THERMALLY STIMULATED ELECTRICAL CONDUCTIVITY OF DOPED ZnS-CRYSTALS. Diehl, H.; Scharmann, A. (Univ., Giessen, Ger.). Z. Angew. Phys., 24: 173-80(1968). (In German).

Thermally stimulated electrical conductivity (TSL) and thermoluminescence (TLu) of doped ZnS crystals were measured after uv excitation. Correlations between TLu and TSL, the dependence of TLu and TSL on the temperature of excitation, the activation energies of TLu and TSL, redistribution of trapped electrons, and trap filling by electron injection have been investigated. The results are discussed with respect to existing models. (auth)

22249 MECHANICAL PROPERTIES OF IRRADIATED SODIUM FLUORIDE SINGLE CRYSTALS CONTAINING A URANIUM IMPURITY. Alybakov, A. A.; Shamyrkanov, Y. (Inst. of Physics and Mathematics, Frunze, USSR). Sov. Phys.-Cryst. (Engl. Transl.), 12: 635-6(Jan.-Feb. 1968).

Translated from Kristallografiya, 12: 726-7(July-Aug. 1967).

Pure and uranium-containing single crystals of sodium fluoride were irradiated with x and γ rays. The microhardness of both the pure and impure crystals increased with increasing radiation dose. The shift in dislocations arising under the action of the diamond pyramid was also determined. (A.G.W.)

22250 NUCLEAR MAGNETIC RESONANCE IN A ROTATING MAGNETIC FIELD. Bradbury, A.; Eades, R. G.; McCarten, J. G. (University Coll. of North Wales, Bangor). Phys. Lett., 26A: 405-6(Mar. 23, 1968).

Proton magnetic resonance of liquid paraffin has been observed in a magnetic field of 270 Oe rotating at 25 kHz. (auth)

22251 EVIDENCE FOR FISHER'S CORRELATION FUNCTION IN IRON FROM CRITICAL NEUTRON SCATTERING. Bally, D.; Popovici, M.; Totia, M.; Grabcev, B.; Lungu, A. M. (Inst. for Atomic Physics, Bucharest). Phys. Lett., 26A: 396-7(Mar. 23, 1968).

Temperature dependence of the critical small-angle scattering of 1.25 Å neutrons in iron is found to indicate a small deviation of the asymptotic spin pair correlation function from the Ornstein–Zernike form, and to confirm Fisher's prediction concerning the character of this deviation. (auth)

22252 HETEROEPITAXY OF MOLYBDENUM ON TUNGSTEN FROM THE LIQUID STATE. Chistyakov, Yu. D.; Pekarev, A. I.; Gartman, M. V. (Inst. of Steels and Alloys, Moscow). Sov. Phys.-Cryst. (Engl. Transl.), 12: 597-600(Jan.-Feb. 1968).

Translated from Kristallografiya, 12: 688-93(July-Aug. 1967).

Electron beam zone recrystallization has been used to produce epitaxy on a tungsten single crystal. A section perpendicular to

the interface has been examined for substructure and composition variation by microhardness testing and x-ray methods. The tungsten concentration shows a sharp fall within 5 to 10 μ in the direction of growth of the new phase, which is followed by a slower fall. There is a coherent boundary between the molybdenum and tungsten, which is represented by a subboundary with an orientation change of 5 to 6′. Growth of the solid solution of tungsten in molybdenum is accompanied by the formation of a banded substructure. The mechanism is determined by the phase diagram of the elements. (auth)

22253 W_6Fe_7-TYPE COMPOUNDS IN THE Nb–Fe, Ta–Fe, AND Ta–Co SYSTEMS. Kripyakevich, P. I.; Gladyshevskii, E. I.; Skolozdra, R. V. (Lvov State Univ.). Sov. Phys.-Cryst. (Engl. Transl.), 12: 525-7(Jan.-Feb. 1968).

Translated from Kristallografiya, 12: 600-3(July-Aug. 1967).

The crystal structures of NbFe and $Ta_{1\pm x}Fe$ have been determined. These compounds, as well as the compound $Ta_{1\pm x}Co$, belong to the W_6Fe_7 structure type. (auth)

22254 NEW COMPOUNDS OF THE $MgZn_2$ TYPE IN SYSTEMS OF RARE-EARTH METALS WITH RHENIUM. Cherkashin, E. E.; Teslyuk, M. Yu.; Frankevich, D. P. (Lvov Univ.). Sov. Phys.-Cryst. (Engl. Transl.), 12: 617-18(Jan.-Feb. 1968).

Translated from Kristallografiya, 12: 712-13(July-Aug. 1967).

Powder patterns of Re (66.7 at. %) with Gd, Tb, Dy, Er, and Lu (33.3 at. %) were examined. All of the alloys were found to be homogeneous, the main phase being RRe_2 with the $MgZn_2$ structure. Lattice constants of the compounds are tabulated. RRe_2 is apparently the only compound formed in these systems. (A.G.W.)

22255 MAGNETIC RESONANCE SPECTROSCOPY. Hecht, Harry G. Allen Series. Wiley Series in Pure and Applied Spectroscopy. New York, John Wiley and Sons, Inc., 1967. 171p. $5.95.

The following subject areas are described: (1) review of quantum mechanical foundations, (2) basic magnetic resonance theory, (3) nuclear magnetic resonance, (4) electron paramagnetic resonance, (5) double resonance, and (6) nuclear quadrupole resonance. (M.O.W.)

Theoretical Physics

22256 SOLUTION OF THE STOERMER PROBLEM FOR A VERY GREAT MOMENT OF MOMENTUM. Godart, Odon; Dejaiffe, Rene (Univ. Catholique, Louvain, Belg.). Ann. Soc. Sci. Brux. Ser. 1, 81: 213-30(Dec. 31, 1967). (In French).

A complete solution of the Stoermer problem in a restricted case is given. The dipole singularity is regularized by the use of a variable that could be extended to the more general problem. A new geometrical representation of the families of trajectories enhances the qualitative particularities of the solution. (auth)

22257 ANALYTIC AND ALGEBRAIC RELATIONS BETWEEN SOME CLASSICAL QUANTUM-MECHANICAL PROBLEMS. Giovannini, A.; Tonietti, T. (Univ., Turin). Nuovo Cim., 54A: 1-14(Mar. 1, 1968).

The combined use of the factorization theory, of the algebras arising from this theory and of the "no Inönu–Wigner contraction" suggests a general method for analyzing the algebraic and analytic relations between some classical quantum-mechanical problems, that in principle can be applied to all the physical problems classified by Infeld and Hull. As an example the cases of the radial equations of the hydrogen atom, of the harmonic oscillator and of the constant potential are discussed. Because of the generality of the results, these problems are studied for arbitrary dimensions. Thus a full understanding of the analytic and algebraic structures and relations of the three problems is obtained. The relation of these results with those reported in the literature is analyzed. A generalization of the Bergmann–Frishmann relation is obtained. (auth)

22258 COVARIANT HAMILTONIAN DYNAMICS WITH INTERACTIONS. Garrod, Claude (Univ. of California, Davis). Contract AT(11-1)-gen-10. Phys. Rev., 167: 1143-5(Mar. 25, 1968). (UCD-CNL-71).

It is shown that a covariant canonical formalism may be developed for a finite number of classical interacting particles. The formalism leads to integro-differential equations of motion (in phase space) similar in structure to those encountered in the recent work of Van Dam and Wigner or the older covariant "action principles" of Tetrode, Fokker, and Wheeler and Feynman. (auth)

22259 SOLITONS AND BOUND STATES OF THE TIME-INDEPENDENT SCHROEDINGER EQUATION. Zabusky, Norman J. (Bell Telephone Labs., Whippany, N. J.). Phys. Rev., 168: 124-8(Apr. 5, 1968).

A numerical calculation validates the correspondence between the soliton nonlinear asymptotic solutions of the time-dependent Korteweg–deVries equation and the bound states of the one-dimensional time-independent Schrödinger equation. Here the attractive potential of the Schrödinger equation is equal to the initial condition of the Korteweg–deVries equation. A situation is examined where an oscillatory state remains after solitons have emerged. (auth)

22260 ORDINARY AND HIGHER RANDOM-PHASE APPROXIMATIONS ON THE LUTTINGER MODEL. Kupelian, N. J. (Univ. of Washington, Seattle). Contract AT(45-1)-1388B. Phys. Rev., 168: 187-92(Apr. 5, 1968).

The exactly solvable Luttinger model for a system of one-dimensional, massless, two-component fermions interacting via general two-body forces is used as a test case for a systematically generated sequence of decoupling approximations commonly referred to as random-phase approximations (RPA) of which the simple RPA is the lowest. It is found, irrespective of both the nature and strength of the interaction, that the exact (collective) spectrum, as well as the exact correlation energy, can already be be obtained in the simple RPA, and furthermore, that the next higher RPA gives a vanishing correction to these quantities. It is also shown, quite in contradistinction to the exact result, that the free-gas momentum distribution $\bar{n}_k$ persists in the second RPA as well as in the first, thereby eliminating the higher RPA as a possible approach to the calculation of $\bar{n}_k$. Thus, in the context of this particular model, although the first few orders of RPA are highly effective for calculating the excitation spectrum and correlation energy, they are sensibly powerless in their ability to predict any variation in structure beyond that of the free-gas distribution, a result that most probably holds as well in the realistic three-dimensional case. (auth)

22261 INITIAL-VALUE METHODS FOR THE BASIC BOUNDARY-VALUE PROBLEM AND INTEGRAL EQUATION OF RADIATIVE TRANSFER. Kagiwada, Harriet; Kalaba, R. E. (RAND Corp., Santa Monica, Calif.). J. Comput. Phys., 1: 322-9(Feb. 1967).

The problem of radiative transfer is considered in a plane-parallel atmosphere which absorbs radiation and scatters it isotropically, there being a continuous distribution of primary internal sources of radiation. The aim is to produce an effective numerical technique for calculating the internal intensity and the source functions. A major consideration is the computer's ability to solve initial-value problems for large systems of ordinary differential equations. New differential–integral equations are derived for the internal intensity at a fixed point and direction, and the source function at a fixed point, the new independent variable being the thickness of the atmosphere. Using standard quadrature techniques, these equations are approximated by systems of ordinary differential equations whose numerical treatment is straightforward. This work may be viewed as a new approach to the study of integral equations and linear unstable two-point boundary-value problems. (auth)

22262 RELATION BETWEEN MEASUREMENT THEORY AND SYMBOLIC LOGIC. Hack, M. N. (Argonne National Lab., Ill.). Nuovo Cim., 54B: 147-8(Mar. 11, 1968).

The possibility that the orthodox interpretation of measurement is not entirely spurious but is in fact presenting a significant clue is explored. It is found that if one adopts this position, then one is compelled to use a basic description not essentially different from Platonic realism. (J.F.P.)

22263 EXACT SOLUTION OF MILNE'S PROBLEM WITH A GENERAL SCATTERING LAW. Trombetti, T. (Comitato Nazionale per l'Energia Nucleare, Bologna). Nucl. Sci. Eng., 32: 111-19(Apr. 1968).

The solution of transport problems in semi-infinite media when the scattering function is an N'th-order polynomial is considered. Case's singular eigenfunction expansion is used to obtain a compact solution of Milne's problem in the nonconservative case in terms of an appropriate X function. The coefficients of the M + 1 discrete eigenfunctions are found by solving a nonhomogeneous set of N + M + 1 algebraic linear equations. The coefficient of the continuum of eigenfunctions and the emergent flux are at last reported. (auth)

22264 MATHEMATICAL VERIFICATION OF A CERTAIN MONTE CARLO SAMPLING TECHNIQUE AND APPLICATIONS OF THE TECHNIQUE TO RADIATION TRANSPORT PROBLEMS.

Coleman, W. A. (Oak Ridge National Lab., Tenn.). Nucl. Sci. Eng., 32: 76-81(Apr. 1968). (ORNL-TM-1944).

The first section of this paper is a mathematical construction of a certain Monte Carlo procedure for sampling from the distribution $F(X) = \int_0^X \Sigma(x) \exp[-\int_0^x \Sigma|v|dv]dx$, $0 \leq X$. The construction begins by defining a particular random variable λ. The distribution function of λ is developed and found to be identical to $F(X)$. The definition of λ describes the sampling procedure. Depending on the behavior of $\Sigma(x)$, it may be more efficient to sample from $F(X)$ by obtaining realizations of λ than by the more conventional procedure described in the paper. Section II is a discussion of applications of the technique to problems in radiation transport where $F(X)$ is frequently encountered as the distribution function for nuclear collisions. The first application is in charged particle transport where $\Sigma(x)$ is essentially a continuous function of x. An application in complex geometries where $\Sigma(x)$ is a step function, and changes values numerous times over a mean path, is also cited. Finally, it is pointed out that the techniques has been used to improve the efficiency of estimating certain quantities, such as the number of absorptions in a material. (auth)

22265 INITIAL-BOUNDARY VALUE PROBLEM FOR A NONLINEAR HYPERBOLIC EQUATION IN RELATIVISTIC QUANTUM MECHANICS. Sather, Jerome (Univ. of Utah, Salt Lake City). J. Math. Mech., 16: 27-30(July 1966).

Nonlinear hyperbolic equations of the special form $U_{tt} - \Delta_u + u|u^\gamma = f$ ($\gamma > 0$) are of interest because of their use in quantum mechanics. The case $\gamma = 2$ in four-dimensional space-time is important in relativistic quantum mechanics; u is some field quantity, and the inhomogeneous term f represents sources of energy in the field. Existence theorems for weak and strict solutions and the continuity of weak solutions with respect to the data of the initial boundary-value problem are established. (IAA)

22266 RELATIVISTIC SYMMETRIC HAMILTONIAN AND THE FOLDY-WOUTHUYSEN TRANSFORMATION. Sheth, C. V. (Karnatak Univ., Dharwar, India). Nuovo Cim., 54A: 549-51 (Apr. 1, 1968).

The Foldy-Wouthuysen transformation was applied to the Biedenharn-Swamy relativistic-symmetric Hamiltonian. Examination of terms up to order $1/m^2$ at the nonrelativistic limit reveals the existence of a term in addition to those obtained in the case of a usual Dirac Hamiltonian. This corresponds to a vector potential arising out of the rotating coordinate system in which the particle has closed orbits. (auth)

22267 INTRODUCTION A LA THEORIE GENERALE DU TRANSFERT DES PARTICULES. (Introduction to the General Theory of the Particle Transport). Kourganoff, V. Cours et Documents de Mathematiques et de Physique. New York, Gordon and Breach, Science Publishers, Inc., 1967. 215p. $10.00.

The book is designed for students commencing specialization in the study of the propagation of photons or neutrons in a material medium. The physical nature of the problem of transfer is illustrated on a very simple model, showing immediately the two principal physical characteristics of transfer: the existence of an "extinction" by pure scattering and the anisotropy of the field of mobile particles. A precise and detailed description is then given of the different concepts used to represent a field of mobile particles. The description is then given of the interactions of a field of mobile particles with the macroscopic elements of a material medium. The formal solution of the transfer equation is given. The J_{op} operator and the Fick law and its generalization are considered. Conditions of the limits for the $\Phi(P)$ function in the scattering equation are given. Mechanical effects of radiation (radiation pressure) and applications to the theory of the internal structure of stars are discussed in conclusion. (J.S.R.)

PHYSICS (HIGH ENERGY)

Particle Interactions and Properties (Experimental)

Refer to abstract 22327.

Electromagnetic

Refer also to abstract 22342.

22268 (CONF-670923–, pp 48-56) ANOMALOUS MAGNETIC MOMENT OF THE μ^-. Bailey, J.; Bartl, W.; Brown, R. C. A.; Farley, F. J. M.; Jostlein, H.; van der Meer, S.; Picasso, E. (European Organization for Nuclear Research, Geneva (Switzerland)).

A preliminary report is given on results thus far obtained on the anomalous g-factor of the meson (μ^-). The decay electron counts modulated by the g-2 frequency of the mesons (μ^-) are shown. The mean dilated lifetime obtained from the data is 26.35 ± 0.03 μ sec, and the anomalous g-factor $a = (g-2)/2$ is $(11666 \pm 5)(10^{-7})$ and is compared with the theoretical value $(11656)(10^{-7})$. (J.F.P.)

22269 (CONF-670923–, pp 59-77) NUCLEON FORM FACTORS WITH ELECTRONS UP TO 6 GeV. Weber, G. (Deutsches Elektronen-Synchrotron, Hamburg (West Germany)).

The electron–nucleon scattering experiments below 6 GeV are summarized. It is found that the scaling law $G_{EP} = G_{MP}/\mu_P = G$ is satisfied for $q^2 \leq 100$ f^{-2} within the limits of error, in particular $G_{EP} > 0$ for $q^2 \leq 75$ f^{-2}. The simple dipole fit $G(q^2) = (1 + q^2/m^2)^{-2}$; $m^2 = 0.71$ GeV^2 represents all available data very well. For $q^2 \leq 30$ f^{-2}, the scaling law is also satisfied for the magnetic form factor of the neutron, $G_{MN}/\mu_N = G(q^2)$. The charge form factor of the neutron is small, probably $\lesssim 0.2$, but not $\equiv 0$. (J.F.P.)

22270 (CONF-670923–, pp 102-8) POSITRON SCATTERING. Pine, J. (California Inst. of Tech., Pasadena).

Previous experiments are discussed which compare elastic electron–proton and elastic positron–proton scattering at identical energies and angles. Also theoretical work relating to these experiments is briefly reviewed. Measured values of the ratio of positron–proton scattering to electron–proton scattering, corrected for the difference arising from the radiative corrections, and the energies and angles at which these data are plotted are shown. (J.F.P.)

22271 (CONF-670923–, pp 128-55) EXPERIMENTS ON INELASTIC ELECTRON SCATTERING. Hand, L. (Cornell Univ., Ithaca, N. Y.).

The kinematics of inelastic electron scattering as seen by the experimenter is reviewed. Six previous experimental contributions are described. These include single-arm measurements, coincidence experiments, and an experimental check on the sum rule in carbon. (J.F.P.)

22272 (CONF-670923–, pp 156-95) REVIEW OF WHAT HAS BEEN LEARNED ABOUT NUCLEAR AND NUCLEON STRUCTURE WITH ELECTRON MACHINES. Walecka, J. D. (Stanford Univ., Calif.).

The review of nuclear and nucleon structure determined from electron scattering is restricted to the case where only the final electron is detected. Some of the physics learned from two-dimensional surfaces is discussed for both nucleons and nuclei. Scattering to discrete levels with examples of this scattering, sum rules, and the excitation of the nucleon are discussed. (J.F.P.)

22273 (CONF-670923–, pp 254-69) PHOTOPRODUCTION OF STRANGE PARTICLES. Strauch, K. (Harvard Univ., Cambridge, Mass.).

A review is given of photon interactions between 1.5 and 6 GeV. The reaction types, photoproduction of $|S| = 1$ resonant states, the reactions $\gamma + p \rightarrow \Lambda^0 + K^+$ and $\gamma + p \rightarrow \Sigma^0 + K^+$, and the photoproduced K^0 beam are covered. Also a comparison with SU(3) and quark model predictions is given. (J.F.P.)

22274 (CONF-670923–, pp 309-36) HIGH-ENERGY PHOTOPRODUCTION. Richter, B. (Stanford Linear Accelerator Center, Calif.).

The most recent experiments on photoproduction reactions leading to two-body final states are summarized. The cutoff in the experiments discussed is at a photon energy of about 3 GeV. The topics discussed are π^+ and π^0, $K^+\Lambda$, and $K^+\Sigma$ photoproduction, and other experiments. (J.F.P.)

22275 (CONF-670923–, pp 376-86) REPORT ON THE COLLIDING BEAM EXPERIMENTS. Marin, P. (Paris Univ., Orsay (France). Laboratoire de l'Accelerateur Lineaire).

The preliminary results of three experiments performed using colliding beams are reported. An electron–electron scattering experiment is in progress which gives $\Lambda^2 = 0.10 \pm 0.30$ GeV/c^{-2} in the form factor for a distribution predicted from Moller scattering. Also electron–positron annihilation cross sections into $\pi^+\pi^-$ are being measured in two experiments. The cross sections and meson (ρ) $\rightarrow e^+ + e^-$ branching ratio are given. (J.F.P.)

22276 (CONF-670923–, pp 409-51) EXPERIMENTAL QUANTUM ELECTRODYNAMICS. Weinstein, R. (Northeastern Univ., Boston, Mass.).

New results on the photoproduction of electron pairs and muon pairs and how they affect knowledge of the behavior of the lepton propagator are discussed. Also discussed are a series of recent experiments which affect knowledge of the (e,γ) and (μ,γ) vertices for gamma ray propagators in the time-like region. A review of previous experiments is also given in order to show the motivation and framework for the present results. (J.F.P.)

22277 (CONF-670923–, pp 494-509) MEASUREMENT OF THE CHARGE ASYMMETRY IN THE DECAY $K_L^0 \rightarrow \pi^\pm + e^\mp + \nu$. Bennett, Sheldon; Nygren, David; Saal, Harry; Steinberger, Jack; Sunderland, John. (Columbia Univ., New York).

Current experiments above several GeV using muon beams are described. These experiments are proposed or in progress, thus results are not given. One interest is to study through inelastic muon–proton, muon–neutrino, and muon–nuclei interactions the combined phenomena of electromagnetic and strong interactions. Further differences between the muon and electron other than the known mass differences and differences in associated neutrinos are investigated. Lastly quantum electrodynamics is studied in these experiments. (J.F.P.)

22278 (CONF-670923–, pp 527-55) MONOCHROMATIC AND POLARIZED BEAMS OF γ QUANTA. Diambrini-Palazzi, G. (Genoa Univ. (Italy). Istituto di Fisica, Istituto Nazionale di Fisica Nucleare, Genoa (Italy)).

The experimental methods and techniques available currently or in the immediate future concerning the production of monochromatic and polarized photon beams are described. While monochromatic γ beams would improve the accuracy of the high-energy photoreaction experiments, the use of polarized photon beams is expected to give further insight into this field. The direct methods for polarized photons are bremsstrahlung by polarized electrons, Compton scattering of laser photons by high-energy electrons, angular selection of bremsstrahlung in very thin targets suitable for external electron beams, and bremsstrahlung in crystals without any photon angular selection for external or internal beams. Also a method for monochromatic photon beams is e^+e^- annihilation (J.F.P.)

22279 (DESY–67/34) MEASUREMENTS ON INELASTIC ELECTRON–PROTON SCATTERING. Brasse, F. W.; Engler, J. (Deutsches Elektronen-Synchrotron, Hamburg (West Germany)); Ganssauge, E. (Marburg Univ. (West Germany)); Schweizer, M. (Hamburg Univ. (West Germany), Physikalisches Institut (II)). Nov. 1967. 46p. Dep.

The cross section for inelastic electron proton scattering has been measured by detecting the scattered electron alone and by detecting the electron in coincidence with the proton. Data without coincidence were taken at scattering angles of 47.5, 55, and 75° for momentum transfers to the pion nucleon system of 20 and 40 f^{-2} at the first resonance (W = 1236 MeV). One measurement at 32.2° and 40 f^{-2} and one at 47.5° and 60 f^{-2} is also reported. The W was varied for fixed primary energy from 938 to about 1400 MeV. In addition for $q^2_{1236} = 40$ f^{-2}, $\vartheta_e = 32.2°$ and 47.5° and for $q^2_{1236} = 60$ f^{-2} and 47.5° W has been varied up to about 1900 MeV. At the first resonance the cross sections are compared with results of other laboratories as well as with theoretical predictions based both on symmetry groups and dispersion relations. For the latter case there is quite good agreement with the measurements. In the region of the second and third classical resonance cross sections do not agree with the threshold behavior of the resonant parts in this region of momentum transfer. The cross sections, divided by the normalized squared nucleon form factor, increase with $|\vec{q}|^b$, where b increases with W. In the case of the first resonance at $q^2_{1236} = 20$ f^{-2} coincidence measurements between the scattered

electron and the proton were made in order to separate π^0 from π^+ production. The proton was detected at different CM-angles and at different values of W of the pion–nucleon system. The measurements differ from the results of the dispersion relation treatment. (auth)

22280 (JINR-E1-3770) OBSERVATION OF THE $\phi \rightarrow e^+e^-$ DECAY. Astvatsaturov, R. G.; Azimov, M. A.; Baldin, A. M.; (and others) (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of High Energy). 1968. 11p. Dep.

Five events of the $\phi \rightarrow e^+e^-$ decay were identified using spark chambers and Čerenkov total absorption gamma spectrometers. The probability for these events to be simulated by the background is smaller than 0.1%. The new data on the e^+e^--decays of ρ and ω-mesons were obtained. (auth)

22281 BREMSSTRAHLUNG DURING THE COLLISION OF A MUON WITH A QUIESCENT ELECTRON. Galitskii, V. M.; Kel'ner, S. R. Izv. Akad. Nauk SSSR, Ser. Fiz., 31: 1565-7 (Sept. 1967). (In Russian).

Photon emission on collision of a muon with atomic electrons may markedly contribute to the bremsstrahlung of muons on atoms even in the case of high Z, and on collision between a muon and a quiescent electron the recoil of the electron is a major factor. This case is considered for a relativistic muon ($E \gg M$) and for photons with $\omega \gg 1$ (system of units $h = c = m_e = 1$). It is shown that maximum-energy photons emitted in a center-of-momentum system in the direction of the electron momentum have an energy of $\omega \approx 1/2$ in a Lobachevskii system; hence, when $\omega \gg 1$ only the photons emitted at large angles in the center-of-momentum system contribute to the cross section. The process is described with two pairs of diagrams, I and II, taken from the perturbation theory: diagram I corresponds to photon emission by a muon, and diagram II, to photon emission by an electron. (JPRS)

22282 SOME CONSEQUENCES OF THE WU–YANG ASMYPTOTIC BEHAVIOR OF FORM FACTORS. Balachandran, A. P. (Inst. for Advanced Study, Princeton, N. Y. Syracuse Univ., N. Y.); Loeffel, J. J. Phys. Rev., 167: 1322-34(Mar. 25, 1968).

The properties of a class A of form factors F(t) are investigated which include some with the asymptotic behavior suggested by Wu and Yang: $F(t) \sim A \exp[-a(-t)^{1/2}]$, $a > 0$, for large negative t. A simple representation theorem for such form factors is proved. This theorem is then used as the main tool to obtain the results which follow. "Asymptotic lower bounds" are derived for any F(t) of class A, both at large positive and at large negative t. It is shown that any form factor belonging to class A satisfies a generalized unsubtracted dispersion relation. A whole set of sum rules for ImF and ReF on the cut are obtained, generalizing those which follow from a superconvergent dispersion relation. An asymptotic lower bound on the number of changes of sign of ImF and ReF along the cut at large positive t is derived. As an illustration, F(t)'s which have the given asymptotic behavior and whose only singularities are simple poles are constructed according to a simple procedure. An asymptotic lower bound on the number of these poles at large positive t is derived for any F(t) of this type. (auth)

22283 EXPERIMENTAL SEARCH FOR A HEAVY ELECTRON. Boley, C. D. (Massachusetts Inst. of Tech., Cambridge); Elias, J. E.; Friedman, J. I.; Hartmann, G. C.; Kendall, H. W.; Kirk, P. N.; Sogard, M. R.; Van Speybroeck, L. P.; de Pagter, J. K. Contract AT(30-1)-2098. Phys. Rev., 167: 1275-9(Mar. 25, 1968). (MIT-2098-378).

A search for a heavy electron of the type considered by Low and Blackmon was made by studying the inelastic scattering of 5-BeV electrons from hydrogen. The search was made over a range of values of the mass of the heavy electron from 100 to 1300 MeV. No evidence for such a particle was observed. Upper limits on the production cross sections were determined and employed to deduce limits on the values of the electron-photon-heavy-electron coupling constant in Low and Blackmon's theory. (auth)

22284 EXPERIMENTAL CONFIRMATION OF RADIATIVE CORRECTIONS TO BREMSSTRAHLUNG AND PAIR PRODUCTION AT HIGH ENERGIES. Schulz, H. D.; Lutz, G. (Deutsches Elektronen-Synchrotron, Hamburg). Phys. Rev., 167: 1280-3 (Mar. 25, 1968).

Radiative corrections to bremsstrahlung and pair-production cross sections were detected experimentally by measuring the thin-target bremsstrahlung spectrum of 5-GeV electrons with a pair spectrometer. Deviations of up to 5% from lowest-order calculations were observed and found to agree with predictions for radiative corrections given by Mork and Olsen. (auth)

22285 MEASUREMENT OF MULTIPLE-PHOTON COMPTON CROSS SECTIONS. McGie, M. R.; Brady, F. P. (Univ. of California, Davis). Contract AT(11-1-gen-10. Phys. Rev., 167: 1186-9(Mar. 25, 1968). (UCD-CNL-90).

The double and triple Compton cross sections were measured for an incident photon energy of 0.662 MeV and for detectors 120° apart in a plane at 90° to the incident beam. Both the energy spectrum of the outgoing photons and the integrated cross section agree with theory for the double Compton effect. In the case of the triple Compton effect, only an integrated cross section is measured, and no exact theory is available for comparison. (auth)

22286 PRODUCTION SPECTRUM OF GAMMA RAYS IN HIGH-ENERGY INTERACTIONS AND HIGH ENERGY GAMMA RAY INTENSITY AT 2900 m. Heidbreder, E.; Pinkau, K. (Univ., Kiel). Z. Phys., 211: 51-67(Mar. 12, 1968).

An extended array of emulsion and lead plates was exposed at Zugspitze for six months. The results of the measurements carried out on individual high-energy cascades, and families of cascades allow the following conclusions to be drawn: The vertical intensity of electrons and γ-quanta with energy >1000 GeV on Zugspitze (2900 m) is $4.5 + 8.8 \times 10^{-10} cm^{-2} sec^{-1} ster^{-1}$. The energy spectrum of these particles has the shape of a power law with exponent −1.85. The production spectrum of secondary particles in individual interactions is derived, and it steepens with increasing primary energy. Using other evidence one may then conclude that this is due to an increase of multiplicity with primary energy. (auth)

22287 NEW FEATURE IN PHOTOPRODUCTION OF PION PAIRS. Eisenhandler, E.; Mistry, N.; Mostek, P.; Silverman, A.; Talman, R. (Cornell Univ., Ithaca, N. Y.). Phys. Rev. Lett., 20: 758-61(Apr. 1, 1968).

Photoproduction of $\pi^+\pi^-$ pairs of invariant mass from 300 to 500 MeV at angles near 0° was measured at photon energies from 1 to 2 GeV. The cross section is sharply peaked when the di-pion system is produced at 0°, and is coherent for complex nuclei. A simple extension of the Drell process gives good quantitative understanding of the data. No evidence is seen for the hypothetical σ meson. (auth)

22288 ASYMMETRIC MUON-PAIR PHOTOPRODUCTION FROM HYDROGEN. Quinn, Daniel J.; Ritson, David M. (Stanford Univ., Calif.). Phys. Rev. Lett., 20: 890-2(Apr. 15, 1968).

The cross section for the reaction $\gamma + p \rightarrow \mu^- + \mu^- + p$ was measured detecting only the meson (μ^-). The momentum and angle of the detected μ^- and the maximum incident photon energy were chosen such that the undetected μ^+ had to be nonrelativistic. A primary photon energy of 850 MeV was used. The experimentally measured muon counting rate is shown as a function of energy. Previous conclusions of no breakdown of QED are reinforced to similar levels of accuracy. (J.F.P.)

22289 INELASTIC INTERACTIONS INDUCED BY 5 GeV/c MUONS IN NUCLEAR EMULSION. Konishi, T. (Osaka City Univ.); Kusumoto, O.; Ozaki, S.; Teranaka, M.; Wada, T.; Watase, Y.; Ohta, M. Nuovo Cim., 54A: 781-99(Apr. 1, 1968).

Inelastic interactions induced by 5 GeV/c negative muons were studied using K5 emulsion. The events examined have more than about the 100 MeV transfer energy of the muon. The total cross section for the observed events is determined to be $(3.0 \pm 0.4) \cdot 10^{-30}$ cm²/nucleon. About 90 percent of this total cross section is reasonably attributed to pion production. The residual events are consistently explained by the process indicated by "quasi-deuteron" model. It is shown that the single- and double-pion productions pass dominantly through the (3,3) resonance in the case that the squared four-momentum transfer of the muon is less than about 0.1 $(GeV/c)^2$. The distributions of transfer energy and squared four-momentum transfer for the process of pion production are well explained by an empirical formula based on the considerations of Daiyasu et al. (auth)

Weak

Refer also to abstract 22371.

22290 (CONF-670923–, pp 484-93) CHARGE ASYMMETRY IN THE MUONIC DECAY OF THE K_2^0. Dorfan, D.; Enstrom, J.; Raymond, D. (Stanford Univ., Calif.); Miller, D. H.; Paciotti, M. (California Univ., Berkeley).

The observation and measurement of a charge asymmetry in the muonic decay of the long-lived neutral meson (K_2^0) are reported. In particular it is found that the decay rate into $\pi^-\mu^+\nu$ is larger than that into $\pi^+\mu^-\nu$ with the ratio determined as $R_{\mu+}/R_{\mu-} = 1.0081 \pm 0.0027$. This result is a demonstration of CP noninvariance in K_2^0 decay. It is consistent with the theoretical expectation based upon an analysis of previous experimental data. (J.F.P.)

22291 (COO-1195-113) AN UPPER LIMIT ON THE DECAY RATE OF $K_L^0 \rightarrow \pi^+\pi^-\gamma$. Thatcher, Roy Cannon (Illinois Univ., Urbana). 1968. Contract AT(11-1)-1195. 76p. Dep. CFSTI.

Thesis.

In the film from a spark chamber experiment on K_L^0 decays performed in the 28° beam line of the ZGS, a search for the decay mode $K_L^0 \rightarrow \pi^+\pi^-\gamma$ was undertaken. The charged decay products were momentum analyzed in a magnet and identified in a set of range-shower chambers on the basis of their behavior there. The position of the gamma ray conversion point in these chambers was compared with the position predicted on the hypothesis of $K_L^0 \rightarrow \pi^+\pi^-\gamma$. The K_{e3} provided almost the sole background as well as the normalization of the rate measurement. In 962 events with good gamma showers one event was found which fitted the $\pi\pi\gamma$ hypothesis within the spacial resolution. However, the expected background was one event. This result corresponds to an upper limit on the decay rate $R(K_L^0 \rightarrow \pi^+\pi^-\gamma) \leq 7.5 \times 10^3$ sec^{-1} at a confidence level of 90%. The result is compared with the predictions of various theoretical models. The possible connections to other decay processes ($K^\pm \rightarrow \pi^\pm\pi^0\gamma$, $K_L^0 \rightarrow \pi^0\pi^0\gamma$, $K_S^0 \rightarrow \pi^+\pi^-\gamma$) and the feasibilities of CP invariance tests are discussed. (auth)

22292 (MIT-2098-389) A LIMIT ON THE BRANCHING RATIO, $K^+ \rightarrow X^+ + \gamma$. Technical Report No. 86. Friedell, D.; Deutsch, M. (Massachusetts Inst. of Tech., Cambridge. Lab. for Nuclear Science); Cutts, D.; Stiening, R.; Wiegand, C. (California Univ., Berkeley. Lawrence Radiation Lab.). Dec. 1967. Contract AT(30-1)-2098. 8p. Dep. CFSTI.

As a part of the Bevatron spark chamber study of K^+ decays at rest, data were searched for examples of the decay $K^+ \rightarrow X^+ + \gamma$ where X^+ is any long-lived charged particle in the mass range covered, and in particular for the forbidden decay $K^+ \rightarrow \pi^+ + \gamma$. No statistically significant evidence for the existence of these decay modes was found. Candidates were recognized by the relation of the conversion point of a gamma ray to the track of a charged particle. The apparatus was sensitive to decays of the form $K^+ \rightarrow X^+ + \gamma$ for hypothetical particles X^+ having a mass in the interval 183 MeV < m_{X^+} < 202 MeV and in the interval 133 MeV < m_{X^+} < 148 MeV. Assuming that the hypothetical particle X^+ reaches the end of its range without nuclear interactions, one can set an upper limit on the branching ratio for this decay of 3.7×10^{-5} for particles in the latter mass range and 2.6×10^{-5} for particles in the former mass range. If nuclear interactions are included, these limits become 1.52×10^{-4} and 4.4×10^{-5}, respectively. For the specific decay $K^+ \rightarrow \pi^+ + \gamma$ one can set an upper limit on the branching ratio of 5.6×10^{-5}. (auth)

22293 K_{l3}^+ DECAY RATES. Garland, R. (Columbia Univ., New York); Tsipis, Kosta; Devons, S.; Rosen, J.; Tycko, D.; Pondrom, Lee G.; Meyer, S. L. Contract AT(11-1)-881. Phys. Rev., 167: 1225-31(Mar. 25, 1968). (COO-881-117).

An experiment was performed at the Brookhaven Cosmotron to study $K^+ \rightarrow \pi^0 l^+ \nu$. A spark-chamber-magnet system was triggered on any charged particle leaving the target after a K^+ had stopped. Separation between π^+ and μ^+ was performed using momentum and range. Positrons were identified by shower production. On the basis of 300 K_{e3} and 350 $K_{\mu 3}$ events in the momentum range 100 to 220 MeV/c, ratios $K_{e3}/(\text{all } K^+) = 0.044 \pm 0.004$, $K_{\mu 3}/(\text{all } K^+) = 0.035 \pm 0.0030$ were found. The positron spectrum was consistent with a constant form factor. The ratio of constant form factors $\xi = f_-/f_+$ determined from the $K_{e3}/K_{\mu 3}$ branching ratio was $\xi = +1.0 \pm 0.3$. (auth)

22294 DEVELOPMENT OF HIGH ENERGY NEUTRINO EXPERIMENTS AT CERN. Ramm, C. A. (CERN, Geneva). Nature (London), 217: 913-18(Mar. 9, 1968).

Equipment at present under construction, and the new developments foreseen, will increase neutrino event rates by large factors Neutrino experiments will become a major field of high energy physics, leading to a further understanding of the interactions of these important particles. (auth)

22295 RELAXATION OF THE μ^+-MESON SPIN IN CONDENSED MEDIA. Gurevich, I. I.; Makar'ina, L. A.; Meleshko, E. A.; Nikol'skii, B. A.; Roganov, V. S.; Selivanov, V. I.; Sokolov, B. V. Z. Eksp. Teor. Fiz., 54: 432-44(Feb. 1968). (In Russian).

An experimental study is made of the polarization P of the meson (μ^+) in different substances versus the strength of a magnetic field of up to 4000 Oe normal to the direction of the meson (μ^+) spin. The time dependence of the polarization is measured in an interval t = 6 – 150 nanosec. The results thus obtained are analyzed in terms of the muonium mechanism of meson (μ^+) depolarization in matter. (auth)

22296 STUDY OF THE DECAY MODE $K_L \rightarrow \pi e \nu$. Basile, P.; Cronin, J. W.; Thevenet, B.; Turlay, R.; Zylberajch, S.; Zylberszteijn, A. (CEN, Saclay, France). Phys. Lett., 26B: 542-5(Mar. 18, 1968).

The energy variation of form factor in $K_L \rightarrow \pi e \nu$ was measured. The parameter $\lambda_+ = +0.023 \pm 0.012$ is found. Also presented are upper limits on the amount of tensor and scalar interaction that can be present. (auth)

Strong (Baryon-Induced)

Refer also to abstracts 21911–21913, 21922, 21923, 21925, 21926, 21928, 21979, 22313, and 22625.

22297 (BNL-12232) PARTICLE PRODUCTION IN HIGH-ENERGY PROTON–PROTON COLLISIONS. Turkot, Frank (Brookhaven National Lab., Upton, N. Y.). Jan. 1968. 34p. (CONF-680103-6). Dep. CFSTI.

From Conference on High-Energy Collisions of Hadrons, Geneva, Switzerland.

The well-established experimental features of particle production in p + p collisions in the 5 to 30 GeV region are briefly reviewed. Then recent bubble chamber and counter–spark chamber data are surveyed. Various models proposed and used to fit these data are mentioned. It is found that only the gross features are known, and the basic mechanism of particle production is still obscure. (J.F.P.)

22298 AN EXAMPLE OF COMPLETE DISINTEGRATION OF A HEAVY EMULSION NUCLEUS AT 24 GeV/c PROTON COLLISIONS. Deka, G. C. (Cotton Coll., Gauhati, India); Deka, K. C.; Bhuyan, H. R. Indian J. Pure Appl. Phys., 5: 494-5(Oct. 1967).

An event which is a good example in support of the view, that the two stage cascade-evaporation mechanism is unable to explain satisfactorily high-energy disintegrations, is reported. The star consists of 39 heavily ionizing prongs accompanied by only 2 shower particles. The estimation of charge balance and the excitation energy of the target nucleus shows that a heavy emulsion nucleus is completely disintegrated leaving no massive residue. (auth)

22299 INELASTIC INTERACTION CROSS SECTIONS OF NUCLEONS AND π AND K MESONS ON VARIOUS NUCLEI AT HIGH ENERGIES. Volkova, I. V. Izv. Akad. Nauk SSSR, Ser. Fiz., 31: 1472-3(Sept. 1967). (In Russian).

Inelastic interaction cross sections for nucleons and π and K mesons on various nuclei were calculated from the optical model to a quasi-stationary approximation for various values of the elementary cross section σ_0—the cross section of interaction of these particles with nucleons. On the basis of the calculations the paths (in g·cm^{-2}) for nuclear interaction of the particles in water, air, and emulsions were calculated as a function of the elementary cross section σ_0. The total (inelastic + elastic) cross sections for pp, np, π^+p, π^-p, K^+p, and K^-p type interactions, respectively, were found to be 38, 37 to 38, 21.5, 23.5, 19 to 21, and 18 to 19 mbarn, respectively, and the inelastic cross sections, 31, 30 to 31, 18.5 to 19, 2.0, 16 and 14 to 16 mbarn, respectively. (JPRS)

22300 DYNAMIC CHARACTERISTICS OF THE SECONDARY PARTICLES GENERATED BY pp INTERACTIONS AT 20 GeV. Boos, E. G.; Pavlova, N. P.; Pervushina, V. L.; Rus'kina, G. Ya.; Takibaev, Zh. S. Izv. Akad. Nauk SSSR, Ser. Fiz., 31: 1477-9(Sept. 1967). (In Russian).

Inelastic pp interactions in nuclear emulsions irradiated at CERN with protons having a momentum of 19.8 GeV/c were investigated. The overall momentum spectrum of the protons with respect to 253 particles has a broad distribution with a maximum in the region of 0.4 to 0.8 GeV/c. For protons the sharpest change occurred in the magnitude of the transferred 4-momentum $\Delta^2 = (p_f - p_i)^2$. In 2-beam interactions the bulk (80%) of the protons had $\Delta^2 < 1$ (GeV)^2 whereas in 8 to 12-beam interactions $\Delta^2 > 1$ (GeV)^2 for all the protons. An important aspect is that the protons are sharply collimated in the forward–backward direction in the cm system even for events with n > 4, mean inelasticity coefficient K > 0.7, and $\Delta^2 > 1.5$ (GeV)^2. It was found that the averaged approximation of the elementary event by the meson cluster model is unacceptable, since it violates the energy balance if secondary nucleons are taken into account. For energies of up to 10 GeV, the relation between the total inelasticity coefficient and the energy fraction entrained by charged π mesons fits the $\frac{3}{2}$ ratio coefficient ensuing from isotopic invariance, but at energies of 20 GeV the deviations exceed the margin of error. (JPRS)

22301 FAST NUCLEI OF HELIUM IN NUCLEAR DISINTEGRATIONS. Takibaev, Zh. S.; Titova, N. S.; Shalagina, E. V.; Shtern, G. R. Izv. Akad. Nauk SSSR, Ser. Fiz., 31: 1498-1501(Sept. 1967). (In Russian).

Helium nuclei with kinetic energies exceeding 100 MeV (momentum 800 MeV/c) from disintegrations of photoemulsion nuclei,

formed by protons of 2.26, 9 and 19.5 GeV and antiprotons of 2.33 GeV, were investigated. In more than 90% of the cases, doubly charged particles escaped on interaction with the heavy nuclei of the photoemulsion. It was established that the mean kinetic energies of the doubly charged particles and their mean laboratory angles of escape do not change within the region of E_p = 2 to 20 GeV. Emission cross sections of helium nuclei from disintegrations on nuclei of silver and bromine were calculated for various values of E_p within the above range and for kinetic energies of doubly charged particles ranging from 0.140 ± 0.038 to 0.230 + 0.018 GeV. It is shown that the emission of the observed doubly charged particles cannot be described by Hagedorn's statistical theory. On the whole the findings point to the existence of a relation between the processes of intranuclear cascade and the escape of fast helium particles, and they also indicate that cascade nucleons are principally responsible for the formation of helium particles. The considerable multiplicity, softer energy spectrum and more isotropic angular distribution of pions in antiproton–nuclear disintegrations result in corresponding changes in the characteristics of the cascade nucleons and hence also of the helium particles; thus pions also indirectly influence the process of the ejection of fast helium particles. (JPRS)

22302 STUDY OF THE EFFECTIVE GENERATION CROSS SECTION FOR Λ^0, K_1^0 AND $\Sigma^\pm$ PARTICLES IN PROCESSES OF INTERACTION BETWEEN COSMIC RAYS AND NUCLEI OF CARBON, COPPER, TIN, AND LEAD. Apshev, S. Zh.; Sakvarelidze, I. I. (Kabardino-Balkarian State Univ., Nalchik, USSR). Izv. Akad. Nauk SSSR, Ser. Fiz., 31: 1470-1(Sept. 1967). (In Russian).

The investigation deals with the relation of the effective hyperon and K-meson generation cross sections to the atomic weight of the generator material (C, Cu, Sn, Pb) and was performed in the Cosmic Ray Laboratory of the Kabardino–Balkarskii State University 1850 m above sea level. The nuclear showers and unstable particles were recorded with the aid of a duplex rectangular Wilson chamber placed in a magnetic field of 8000 Oe. The particles were identified according to the measurements of curvature of particle tracks and angles of divergence. It was established that the effective generation cross section σ for the Σ^- hyperon in graphite is 0.36 ± 0.2 mb; in Cu, 1.14 ± 0.4 mb; in Sn, 1.87 ± 1.5 mb; and in Pb, 2.9 ± 0.5 mb. For the Σ^+ hyperon the values of σ are as follows: in graphite, 3.66 ± 1.2 mb; in Cu, 7.85 ± 1.2 mb; in Sn, 15.5 ± 1.3 mb; and in Pb, 21.5 ± 1.4 mb. For the Λ^0 hyperon the values of σ are as follows: in graphite, 1 ± 0.25 mb; in Cu, 2.7 ± 0.2 mb; in Sn, 5.3 ± 0.7 mb; and in Pb, 6.3 ± 0.3 mb. For the K_1^0 meson the values of σ are as follows: in graphite, 2.82 ± 0.5 mb; in Cu, 8.2 ± 0.6 mb; in Sn, 17 ± 3 mb; and in Pb, 22 ± 3 mb. Within the margin of experimental error these findings do not contradict the formula $\sigma \sim A^{\frac{2}{3}}$. (JPRS)

22303 n–p DIFFERENTIAL CROSS SECTION AND POLARIZATION AT 199 MeV. Thomas, A. R.; Spalding, D.; Thorndike, E. H. (Univ. of Rochester, N. Y.). Contract AT(30-1)-875. Phys. Rev., 167: 1240-9(Mar. 25, 1968). (UR-875-223).

The relative differential cross sections and polarization parameters for free n-p scattering and for the reaction n + d → p + 2n in which only the proton is detected (bound n-p scattering), were measured at an incident energy of 199 MeV, at two-nucleon c.m. angles between 77° and 158°. The neutron beam used, created by charge-exchange scattering of a polarized proton beam on a deuterium target, had an energy spread of ±12 MeV, a polarization of 73%, and an intensity of 1000 n/sec. The differential cross section σ and the polarization P, for free n-p scattering, the ratio R_M of the bound to the free cross section, and the difference $P - P_b$ between the free and bound polarization parameters are listed. The cross-section measurements agree with those of Kazarinov and Simonov and with the phase-shift solution $(Y\text{-}IV)_{pp}$ of Breit et al. but disagree with the older measurements of Guernsey, Mott, and Nelson. The polarization measurements are in satisfactory agreement with the (less accurate) results of Tinlot and Warner, but in only fair agreement with the phase-shift solution $(Y\text{-}IV)_{np}$. The ratio R_M, typically 0.65 ± 0.04, is significantly smaller than that given by an impulse-approximation calculation, typically 0.76. The difference between polarization parameters for free and bound scattering is consistent with an impulse-approximation calculation but also consistent with zero. (auth)

22304 DIFFERENTIAL CROSS SECTIONS FOR p + p → d + π^+ FROM 1 TO 3 BeV. Heinz, R. M. (Univ. of Michigan, Ann Arbor); Overseth, O. E.; Pellett, D. E.; Perl, M. L. Phys. Rev., 167: 1232-9(Mar. 25, 1968).

The differential and total cross sections for the reaction p + p → d + π^+ were measured in a counter experiment for incident proton kinetic energies of 1.0, 1.3, 1.5, 1.7, 2.0, 2.5, and 2.8 BeV. Values of the differential cross section are given for barycentric deuteron angles θ for $0 \geq \cos\theta \geq -0.97$ in small intervals of $\cos\theta$. From 1.3 to 2.0 GeV, as $\cos\theta$ varies from −0.5 to −1.0, the differential cross section rises, passes through a pronounced maximum, and then decreases rapidly. This maximum propagates from $\cos\theta$ = −0.8 at 1.3 GeV to $\cos\theta$ = −0.94 to 2.0 GeV, and evolves into a sharp peak at $\cos\theta$ = −1.0 for energies above 2.0 GeV. The total cross section decreases rapidly and monotonically with energy from 450 μb at 1.0 GeV to 30 μb at 2.8 GeV. (auth)

22305 ANTIPROTON–PROTON ANNIHILATION INTO SIX CHARGED PIONS AND RESONANCE PRODUCTION IN THE $\bar{p}p \rightarrow 3\pi^+3\pi^-\pi^0$ CHANNEL AT 5.7 GeV/c. Fridman, A. (Centre de Recherches Nucleaires, Strasbourg. Univ., Heidelberg); Maurer, G.; Michalon, A.; Oudet, J.; Schiby, B.; Strub, R.; Voltolini, C.; Cueer, P. Phys. Rev., 167: 1268-75(Mar. 25, 1968).

Based on 3586 six-pronged events, results on $\bar{p}p$ annihilation into six and seven pions at 5.7 GeV/c are presented. The production of ρ, ω, A_1, and A_2 resonances in the $\bar{p}p \rightarrow 3\pi^+3\pi^-\pi^0$ channel was observed. Cross sections for the production of the ρ and ω resonances are given. The partial cross sections for $\bar{p}p \rightarrow \rho^0 2\pi^+2\pi^-\pi^0$ and $\bar{p}p \rightarrow \omega 2\pi^+2\pi^-$ are compared with other experimental data. That the $\bar{p}p \rightarrow \omega 2\pi^+2\pi^-$ cross section is small at 5.7 GeV/c shows that this reaction contributes in a rather important manner to the peak observed in the $\bar{p}p \rightarrow 3\pi^+3\pi^-\pi^0$ cross section at an incident $\bar{p}$ momentum of 3 GeV/c. The data show some indication of bumps in the $(\rho^0\pi^0)$, $(\rho^0\rho^0)$ mass for seven-pions annihilation where ρ^0 is defined as a $(\pi^+\pi^-)$ system having a mass combination in the ρ^0 band. As yet the statistics do not allow a definite conclusion about these effects. By comparison with other experimental data, it seems that the isotropy of the pion angular distribution in the c.m. system increases with the number of outgoing pions. (auth)

22306 NEUTRON–PROTON BREMSSTRAHLUNG AT 208 MeV. Brady, F. P.; Young, J. C.; Badrinathan, C. (Univ. of California, Davis). Phys. Rev. Lett., 20: 750-2(Apr. 1, 1968).

Neutron–proton bremsstrahlung measurements were carried out using a 208-MeV neutron beam produced by deuterons striking an internal Be target in the LRL 184-in. cyclotron. The measured npγ differential cross sections are shown along with corresponding ppγ cross sections. (L.B.S.)

22307 NUCLEAR INTERACTIONS OF VERY-HIGH ENERGY WITH LARGE ENERGY TRANSFER INTO NEUTRAL PIONS. Babayan, Ch. P. (Inst. of Physics, Erevan); Brikker, S. I.; Grigorov, N. L.; Podgurskaja, A. V.; Savelyeva, A. I.; Shestoperov, V. Ya.; Buja, Z.; Massalski, J.; Niziol, B. Nuovo Cim., 54B: 26-36(Mar. 11, 1968).

The experimental data were obtained using an apparatus of an area of 10 m^2 installed at Mt. Aragats (3200 m above sea level). The apparatus contained emulsion plates and ionization chambers. Nuclear interactions in which a large fraction of the primary energy is transferred to neutral pions were observed. (auth)

22308 APPLICATION OF THE SATZ SUM RULES TO THE HIGH MULTIPLICITY PROCESSES. Hofmokl, T. (Univ. of Warsaw); Szeptycka, M. Phys. Lett., 26B: 546-8(Mar. 18, 1968).

The relation which follows from the Satz additive quark model between cross sections for the reactions $\pi p \rightarrow N(k+1)\pi$ and $pp \rightarrow NNk\pi$ is found to be in agreement with experimental data for k = 4 and k = 5. (auth)

22309 PARTICLE PRODUCTION FROM COPPER AND URANIUM TARGETS BY 8 GeV/c PROTONS. Davies, J. D. (Univ. of Birmingham, Eng.); Dowell, J. D.; Hattersley, P. M.; (and others). Nuovo Cim., 54A: 608-19(Apr. 1, 1968).

A detailed study was made of the production of K^- and π^- mesons at 690, 745, and 935 MeV/c by 8 GeV/c protons incident on copper and uranium targets. Yields are reported as a function of target length over the range of production angles 0° to 15°. The maximum yield for thick targets occurs at about 7°, and it is shown that this may be understood in terms of reabsorption of secondaries within the target. The ratios K^-/π^-, p/π^+, $\bar{p}/\pi^-$ were also measured within the momentum range 600 to 2600 MeV/c. (auth)

Strong (Meson-Induced)

Refer also to abstracts 21348, 21923, 21927, and 22299.

22310 (CEA-R-3146) MESURES DES SECTIONS EFFICACES DIFFERENTIELLES π^+p A 410 MeV ET 490 MeV VERS L'AVANT. (Measurement of π^+p Forward Elastic Differential Cross Sections at 410 and 490 MeV). Banner, Marcel (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires). 1967. 56p. (In French). Dep.

Thesis. Submitted to Faculte des Sciences, Univ. of Paris, Orsay, France.

Measurements of the π^+p forward elastic differential cross sections were performed with a missing mass spectrometer using spark chambers. Photographs were automatically scanned. Phase shift analysis of experimental results leads to three solutions. Experiments are indicated which ought to permit overcoming ambiguity. (auth)

22311 (CONF-670923–, pp 452-83) LEPTONIC DECAYS OF VECTOR MESONS. Ting, Samuel C. C. (Massachusetts Inst. of Tech., Cambridge).

The results of four experiments where the reported number of $\rho \rightarrow l^+ + l^-$ events are ≈100 are reviewed. In these experiments the meson (ρ) is produced via meson (π^-) and photon reactions with nuclei. The invariant mass spectra and the branching ratio for rho decay are given. (J.F.P.)

22312 (INR-837/VI/PH) SIX-PRONG INTERACTIONS OF 16 GeV/c π^- WITH PROTONS. Boeckmann, K.; Drevermann, H.; Sternberger, K.; (and others) (Institute of Nuclear Research, Warsaw (Poland)). 1967. 13p. Dep.

About 4000 six-prong interactions of 16-GeV/c π^- with protons recorded in the 2m HBC were measured. Cross sections for fitted channels are given. In the reaction $\pi^-p \rightarrow p\,2\pi^+3\pi^-$ copious production of $N^{2++}(1236)$ (~35%) and ρ^0 (~60%) is observed. In the reaction $\pi^-p \rightarrow p\,2\pi^+3\pi^-\pi^0$ the $N^{2++}(1236)$ production is weaker, but there is a good evidence for ρ^0 (~30%) and ω^0 (~15%) production. Single particle distributions are discussed as well as the Goldhaber effect. (auth)

22313 APPLICATION OF A NEW METHOD FOR THE ANALYSIS OF REACTIONS IN VELOCITY-SPACE IMAGES TO π^-N AND pN INTERACTIONS AT 17 AND 24 GeV/c. Belyakov, V. A.; Bubelev, E. G. Izv. Akad. Nauk SSSR, Ser. Fiz., 31: 1491-4(Sept. 1967). (In Russian).

The new method of analyzing nuclear reactions in images of the Lobachevskii-Einstein velocity space (Bubelev, E. G., Proc. XII Int. Conf. High-Energy Physics, 1966, p 317 [8a, 12], Berkeley, (1967)) was used to analyze π^-N and pN interactions at 17 and 24 GeV/c in photoemulsion. Relativistically invariant longitudinal (Lobachevskii) and transverse ($\omega^\perp$) velocity diagrams, representing the Euclidean images of mutually orthogonal projections of kinematic figures corresponding to the π^-N and pN events were separately analyzed for both these types of events. As a result the type of kinematics pertaining to events with simple as well as with fairly complex kinematic figures could be determined. The events with two particle groups were classified in the binary type and the events with three particle groups (the third group of 2 to 4 particles is located in the neighborhood of the cm reaction), in the "ternary" (or quasi-three-particle) type. The isolated particle groups were interpreted as products of the disintegration of quasi particles, i.e., of excited nucleons and mesons. The findings showed that at energies of 15 to 30 GeV the above method can be used to isolate the physically essential part of experimental information on the kinematics of inelastic reactions, if the latter is sufficiently complete. (JPRS)

22314 STUDY OF THE GENERATION OF ρ^+ AND N^{*++} RESONANCES IN THE $\pi^+p \rightarrow \pi^+p\pi^0$ REACTION FOR A π^+ MESON MOMENTUM OF 2.34 GeV/c. Gramenitskii, I. M.; Kanazirski, Kh. M.; Moiseev, A. M.; (and others). Izv. Akad. Nauk SSSR, Ser. Fiz., 31: 1483-6(Sept. 1967). (In Russian).

Two-beam events selected during an examination of 60,000 photographs obtained within a liquid-hydrogen chamber in a beam of π^+ mesons with a momentum of 2.34 GeV/c were analyzed. Of the total of 7000 2-beam events approximately 1400 corresponded to the reaction $\pi^+p \rightarrow \pi^+p\pi^0$. For each event the effective masses of all the double combinations, the transferred momenta and various angular characteristics were calculated on a computer. The production cross sections of the ρ^+ meson and the isobar N^{*++} were determined as a function of the distribution density of events on the Dalitz diagram and were found to be 1.2 ± 0.2 and 0.4 ± 0.06 mb, respectively. Square distributions of 4-momentum transfer were determined. It turned out that the production of ρ^+ and N^{*++} occurs chiefly in the presence of a low transferred momentum; hence it may be assumed that the reactions involved are described by diagrams with single-particle exchange. A study of the angular distribution of the decay products of resonance made it possible to determine the quantum numbers of the decaying particles. The angular distributions in the rest system of resonance were found to be associated with elements $\rho mm'$ of the density spin matrix describing the state of resonance with a specific spin and parity prior to decay. The type of the density matrix depends on the mechanism of formation of the resonance. It is shown that the absorption model predicts values of $\rho mm'$ that are closer to experimental findings. (JPRS)

22315 CERTAIN FEATURES OF πN INELASTIC COLLISIONS IN THE PRESENCE OF A MOMENTUM OF 17 GeV/c. Anzon, Z. V.; Vinitskii, A. Kh.; Strel'tsov, I. S.; Takibaev, Zh. S.; Chasnikov, I. Ya.; Shakhova, Ts. I. Izv. Akad. Nauk SSSR, Ser. Fiz., 31: 1474-6(Sept. 1967). (In Russian).

πN-interactions in a 600 μ thick stack of films of nuclear photoemulsion were investigated at CERN on irradiating the stack with a beam of negative π-mesons (momentum of 17 GeV/c). Interactions formed on free and quasi-free nucleons of emulsion were identified by tracing the primary-particle tracks. Altogether 451 inelastic πN-interactions were selected and analyzed. The particles were identified according to measurements of ionization and multiple scattering. The ionization losses in the photoemulsion were found to be satisfactorily described by Sternheimer's equation with the parameters T = 2 keV, I = 270 eV. The momentum spectra of protons in even-numbered (πp) and odd-numbered (πn) beam interactions with respect to an incident π^--meson having the momentum of 17 GeV were found to differ; repeated analysis, with determination of the number of protons per interaction in πN- and π-nuclear collisions showed that the number of "gray" protons per interaction in both these types of collisions coincides. These findings as well as the comparison of the spectra of "gray" protons show that the difference in the spectra of protons for πp- and πn-interactions apparently cannot be attributed to the effect of the nucleus. In order to confirm this difference, it would be advisable to reproduce the experiment in a deuterium bubble chamber of sufficiently large dimensions, the more so considering that the recoil protons can serve as a criterion for determining the neutron momentum prior to collision, i.e., protons can be employed as an "observer." (JPRS)

22316 EXPERIMENTAL DETERMINATION OF THE K Σ N PARITY USING A POLARIZED TARGET. Dieterle, B. D.; Arens, John F.; Chamberlain, Owen; (and others) (Univ. of California, Berkeley). Contract W-7405-eng-48. Phys. Rev., 167: 1190-8 (Mar. 25, 1968). (UCRL-17230(Rev.)).

The KΣN parity was determined using the reaction $\pi^+p \rightarrow K^+\Sigma^+$. A crystal containing polarized protons was used as the target. The counting rates were compared for events produced from protons polarized parallel and antiparallel to PΣ, where PΣ is the polarization of Σ's produced from unpolarized protons and has been previously measured. A higher counting rate was obtained for events for which the protons were polarized parallel to PΣ. This means that the KΣN parity of $\Pi_{K\Sigma N} = \Pi_{\pi p} = -1$. This result depends only on the assumptions of spin $\frac{1}{2}$ for the Σ and parity conservation in the reaction. The relative probability of odd-versus-even KΣN parity is 21 : 1. The result agrees with the usual expectations (as from SU_3) and with a previous experimental determination. (auth)

22317 MEASUREMENT OF THE Σ^- POLARIZATION IN THE REACTION $\pi^- + p \rightarrow \Sigma^- + K^+$. Weldon, D.; Steiner, H., Shapiro, Gilbert; (and others) (Univ. of California, Berkeley). Contract W-7405-eng-48. Phys. Rev., 167: 1199-1202(Mar. 25, 1968). (UCRL-17152(Rev.)).

The average polarization of the Σ^- produced in the reaction $\pi^- + p \rightarrow \Sigma^- + K^+$ was measured between center-of-mass angles 134° and 166° for an incident π^- momentum of 1145 MeV/c. A polarized proton target was used, and the Σ^- polarization was found by measuring the difference in the production rate of K^+ mesons for protons polarized along the production-plane normal and against it. Spark chambers were used to record the π^- and K^+ trajectories, and the π^- momentum was obtained from a magnetic spectrometer while the K^+ momentum was obtained from a range telescope. Each event was kinematically reconstructed in a one-constraint fit to help eliminate events produced from protons bound in heavy nuclei of the target. The Σ^- polarization was found to be -0.36 ± 0.46. (auth)

22318 FORWARD π^-p CHARGE-EXCHANGE SCATTERING BETWEEN 561 AND 2106 MeV/c. Risk, Winthrop S. (Princeton Univ., N. J.). Phys. Rev., 167: 1249-60(Mar. 25, 1968).

Final results are presented from a spark-chamber experiment performed at the Princeton-Pennsylvania Accelerator to measure the differential cross section near 0° for the reaction $\pi^-p \rightarrow \pi^0n$. The data are extrapolated to 0° and the results of the extrapolation are compared with the results of other experiments and with dispersion relation predictions. The values of the forward-scattering amplitude for the fifteen values of incident π^- momentum at which measurements were made are as follows: (p (MeV/c), $(d\sigma/d\Omega)_0^0$ (mb/sr)): (561, 3.28), (636, 2.95), (687, 3.38), (750, 2.49), (802, 1.33), (930, 2.42), (1005, 3.15), (1030, 3.43), (1077, 1.70), (1134, 1.04), (1434, 0.31), (1579, 0.56), (1711, 0.73), (1914, 0.87), (2106, 0.56). The combined statistical and systematic uncertainties in these values are about ±9%. A description of the apparatus, a discussion of the methods of analysis, and a discussion of the errors

contributing to the uncertainties in the above results are included in the text. (auth)

22319 MEASUREMENT OF POLARIZATION IN π^-p ELASTIC SCATTERING FROM 229 TO 390 MeV. Arens, John F.; Chamberlain, Owen; Dost, Helmut E.; Hansroul, Michel J.; Holloway, Leland,E.; Johnson, Claiborne H.; Schultz, Claude H.; Shapiro, Gilbert; Steiner, Herbert M.; Weldon, David M. (Univ. of California, Berkeley). Contract W-7405-eng-48. Phys. Rev., 167: 1261-7 (Mar. 25, 1968). (UCRL-17153(Rev.)).

The polarization parameter in elastic π^-p scattering was measured, at the Berkeley 184-in. synchrocyclotron, with the use of a polarized proton target. At 318-, 337-, and 390-MeV incident pion kinetic energy, the angular range from 70° to 180° in the center-of-mass system was covered. At 229 MeV, polarization measurements were made in the angular range 150° to 180°. Phase-shift analyses, using these and other published data, were made at the two lowest energies. (auth)

22320 PROPERTIES OF THE Ξ^- AND THE Ξ^* (1817) FROM K^-p INTERACTIONS ABOVE 1.7 BeV/c. Merrill, Dean W.; Button-Shafer, Janice (Univ. of California, Berkeley). Contract W-7405-eng-48. Phys. Rev., 167: 1202-24(Mar. 25, 1968). (UCRL-17631).

A sample of 2529 Ξ^- hyperons, produced in $\Xi^-K^+,^0\pi^0,^+$, and $\Xi^-K^+,^0\pi^-,^0\pi^+$ final states by K^- (in hydrogen) at incident momenta from 1.7 to 2.7 BeV/c, was analyzed. The data are from an exposure of 26 events/μb ("K-63" run) in the Alvarez 72-in. bubble chamber; approximately 85% of the Ξ^- events with visible Λ decay were analyzed. A maximum-likelihood fit (with $\alpha_\Lambda = 0.656 \pm 0.055$ and with the Ξ spin = $\frac{1}{2}$) yields the following values of Ξ^- decay parameters: $\alpha_{\Xi^-} = -0.375 \pm 0.051$; $\Phi_{\Xi^-} \equiv \tan^{-1}(\beta_{\Xi^-}/\gamma_{\Xi^-}) = 9.8° \pm 11.6°$. Spin analysis of the 3278 Ξ^- decays from the K-63 and K-72 (K^-p at 1.2–1.7 BeV/c) experiments gives likelihood results which favor $J_\Xi = \frac{1}{2}$ over $J_\Xi = \frac{3}{2}$ by the equivalent of approximately 2.5 standard deviations. Analysis of the $\Xi^*(1817) \rightarrow \Xi^*(1530) + \pi$ decay mode indicates that the hypotheses $J^P = \frac{1}{2}^+, \frac{1}{2}^-, \frac{3}{2}^-, \frac{5}{2}^+, \frac{7}{2}^-$, etc are favored; but results are inconclusive because of high background as well as poor statistics. Analysis of the $\Xi^*(1817) \rightarrow \Lambda + \bar{K}$ provides no spin or parity discrimination. The K-63 beam channel is briefly described. (auth)

22321 EVIDENCE FOR A MASS ENHANCEMENT IN THE $\bar{\Lambda}$ SYSTEM. Alexander, G.; Firestone, A.; Goldhaber, G.; Shen, B. C. (Univ. of California, Berkeley). Phys. Rev. Lett., 20: 755-7(Apr. 1, 1968).

Results are reported on a study of $\bar{\Lambda}$ and $\bar{\Sigma}^0$ production in the K^+p reaction at 9 GeV/c, carried out with the BNL 80-in. hydrogen bubble chamber. Cross sections were obtained for the following $\bar{Y}^0$ final states: $\bar{\Lambda}pp + \bar{\Sigma}^0pp$, $\bar{\Lambda}pp\pi^0$, $\bar{\Lambda}pn\pi^+$, and $\bar{\Lambda}pp\pi^+\pi^-$. A strong enhancement was observed for low mass value in the $\bar{Y}^0N$ mass distribution, which, if interpreted as a resonance, would correspond to an $I = \frac{1}{2}$ K^* with $M = 2240 \pm 20$ MeV and $\Gamma = 70 \pm 20$ MeV. (L.B.S.)

22322 SOME RARE DECAYS IN INTERACTIONS OF π AND K MESONS WITH CARBON AND IRON. Wehmann, A. W. (Harvard Univ., Cambridge, Mass.); Engels, E. Jr.; Hoffman, C. M.; Innocenti, P. G.; Wilson, Richard; Blanpied, W. A.; Drickey, D. J.; Hand, L. N.; Stairs, D. G. Phys. Rev. Lett., 20: 748-9(Apr. 1, 1968).

An experiment was previously reported on the leptonic decay of vector mesons produced by K^- and π^- bombardment of carbon and iron. Other features of the data are reported based on recently available information; namely: a value for the φ branching ratio; an upper limit for the process $\eta \rightarrow \mu^+\mu^-$; upper limits for $\eta \rightarrow \pi^0\mu^+\mu^-$ and $\omega \rightarrow \pi^0\mu^+\mu^-$; a comparison of the decays $\rho^0 \rightarrow \mu^+\mu^-$ and $\rho^0 \rightarrow e^+e^-$. (L.B.S.)

22323 OBSERVATION OF MULTIPION RESONANCES AT 1630 AND 1720 MeV IN HIGH-ENERGY π^+p COLLISIONS. Baltay, C. (Columbia Univ., New York); Kung, H. H.; Yeh, N.; Ferbel, T.; Slattery, P. F.; Rabin, M.; Kraybill, H. L. Phys. Rev. Lett., 20: 887-9(Apr. 15, 1968).

The results of a bubble chamber investigation of multipion momenta of 6.95 and 8.5 GeV/c are presented. These data provide strong support for the existence of two isospin-1 resonances: a negative G-parity at 1630 ± 10 MeV and a positive G-parity state at 1720 ± 15 MeV having a width of 100 ± 35 MeV. These resonances are produced peripherally with observed production cross sections of the order of 50 μb. The results are based on the analysis of 6959 events of the $\pi^+ + p \rightarrow p + 2\pi^+ + \pi^-$ reaction and 5744 events of the reaction $\pi^+ + p \rightarrow p + 2\pi^+ + \pi^- + \pi^0$. Effective mass distributions which exhibit considerable fine structure are shown. (J.F.P.)

22324 NEW MEASUREMENT OF THE $_\Lambda H^3$ LIFETIME. Keyes, G. (Argonne National Lab., Ill. Northwestern Univ., Evanston, Ill.); Derrick, M.; Fields, T.; Hyman, L. G.; Fetkovich, J. G.; McKenzie, J.; Riley, B.; Wang, L-T. Phys. Rev. Lett., 20: 819-21(Apr. 8, 1968).

The mean life of $_\Lambda H^3$ was measured to be $(2.32^{+0.40}_{-0.31}) \times 10^{-10}$ sec. This does not agree with previous measurements but is completely consistent with theoretical expectations. (auth)

22325 $\pi^+ - {}^4He$ ELASTIC SCATTERING AT 610 MeV/c. Carayannopoulos, N. L.; Head, J. H.; Kwak, N.; Manweiler, J. E.; Stump, R.; Varma, S. (Univ. of Kansas, Lawrence). Phys. Rev. Lett., 20: 822-5(Apr. 8, 1968).

The results of the analysis of $\pi^+ - {}^4He$ elastic scattering at an incident pion laboratory momentum of 610 MeV/c in a ^4He bubble chamber are presented. The total number of events which satisfied the elastic criteria was 869, of which 194 had a discernible recoil track. Two models were used in fitting the experimental results: a strong-absorption model and the multiple-scattering model. The experimental differential cross section is shown together with the impulse approximation and multiple scattering curves. Also shown is the sensitivity of the calculations with respect to the parameters. The multiple-scattering model yields an elastic cross section of 28.9 mb and a total cross section using the optical theorem of 95.2 mb. Using the strong absorption model the elastic cross section is 30.6 mb, and the total cross section is 113.1 mb. (J.F.P.)

22326 LIFETIME OF THE Σ^--HYPERON. Whiteside, H.; Gollub, J. (Oberlin Coll., Ohio). Nuovo Cim., 54A: 537-48 (Apr. 1, 1968).

A new measurement of the Σ^- mean lifetime was obtained from a sample of 506 Σ^- decays and reactions which are produced in a hydrogen bubble chamber and satisfy certain geometrical criteria. By using a maximum-likelihood calculation and making an appropriate correction for $\Sigma^- + p$ interactions in flight, the value obtained for the Σ^- lifetime is $(1.38 \pm 0.07) \cdot 10^{-10}$ s. (auth)

Particle Interactions and Properties (Theoretical)

General

Refer also to abstracts 22262 and 22475.

22327 (AED-C-23-23) HIGH ENERGY PHYSICS INDEX. Volume 6, No. 2 (397-1028). (Zentralstelle fuer Atomkernenergie-Dokumentation, Frankfurt am Main (West Germany)). 1968. 240p. Dep.

A monthly report of the material received at DESY is presented. This report includes both experimental and theoretical physics and covers weak, strong, and electromagnetic interactions, strange particles, accelerators, and methods and instruments. Also covered are symmetry principles and field theory. Author and report number indices are included. (J.F.P.)

22328 (EUR-3744) ANALYSE DE MESURES DE DIFFUSION ELASTIQUE DE PARTICULES NEUTRES, D'APRES LA FORMULE DE BLATT ET BIEDENHARN. (Analysis of Measurements of Elastic Scattering of Neutral Particles, Using the Blatt and Biedenharn Formula). Cao, M. G. (European Atomic Energy Community, Geel (Belgium). Central Nuclear Measurements Bureau). 1968. 60p. (In French). Dep.

BLATT 4 and ERRFIT are two programmes written in FORTRAN IV for IBM 7090 and 360 digital computers. They can be used for calculating, by the least squares method, the values of the τ and $g_{\alpha s l}$ parameters, the theoretical differential cross section and the error therein for the elastic scattering of neutral particles, according to the Blatt and Biedenharn one level formula. (auth)

22329 (INP-559/PL) WSPOLCZYNNIKI CLEBSCHA-GORDANA: PROGRAM DLA MASZYNY ODRA 1003. (Clebsch-Gordan Coefficients: Program for the ODRA 1003 Computer). Gonsior, A. (Institute of Nuclear Physics, Krakow (Poland)). 1968. 17p. (In Polish). Dep.

A program for computing the Clebsch–Gordan coefficients by means of the ODRA 1003 computer is given. (auth)

22330 (ITEF-538) O POSTROENII INVARIANTNYKH AMPLITUD VZAIMODEISTVIYA CHASTITS S PROIZVOL'NYMI SPINAMI. (Designation of Invariance Amplitudes of Interaction of Particles With Arbitrary Spins). Marinov, M. S. (Gosudarstvennyi Komitat po Ispol'zovaniyu Atomnoi Energii SSSR, Moscow. Institut Teoreticheskoi i Eksperimental'noi Fiziki). 1967. 55p. (In Russian). Dep.

A method to construct phenomenological amplitudes for arbi-

trary interactions of particles with any spin is presented. The relativistic particle wave functions are taken in the $2 \cdot (2s + 1)$-component (for spin s) bispinor representation. The vertex functions and the two-body scattering amplitudes are considered in some detail. The method is suitable for considerations of the analytical properties, unitarity, the Feynman graphs, the discrete symmetries, as well as to calculate observable quantities and to fulfil the phase shift analysis. (auth)

22331 (ITF-67-48) ON SUMMATION OF CONTRIBUTIONS FROM THE FEYNMAN DIAGRAMS: AN EXISTENCE THEOREM. III. Petrina, D. Ya. (Akademiya Nauk Ukrainskoi SSR, Kiev. Institut Teoreticheskoi Fiziki). 1967. 28p. Dep.

Linear equations are developed for the Euclidean Green's functions outside perturbation theory. The operator A is proved to be self-adjoint. It is shown that the iterations of the Green's function equations yield all the connected Feynman diagrams. (auth)

22332 (UH-511-23) ANNUAL PROGRESS REPORT OF THE HIGH-ENERGY PHYSICS GROUP, JANUARY 1–DECEMBER 31, 1967. (Hawaii Univ., Honolulu. Dept. of Physics and Astronomy). Feb. 15, 1968. Contract AT(04-3)-511. 20p. Dep. CFSTI.

The report of the high-energy physics group at the University of Hawaii covers research for the year 1967. This research is both experimental and theoretical and includes bubble and spark chamber experiments. (J.F.P.)

22333 DEVELOPMENT LAWS AND PERSPECTIVES OF PHYSICS. Strauss, M. Monatsber. Deut. Akad. Wiss. Berlin, 9: 538-47(1967). (In German).

The preliminary studies to formulate the development laws of physics and to derive from these laws a possible prognosis and strategy for research are outlined. The specific development laws discussed are the tendency to abstraction, reduction of properties to processes, reduction of contingent data, and unification of the theoretical principles. (J.S.R.)

22334 BARYON INHOMOGENEITY IN THE EARLY UNIVERSE. Harrison, E. R. (Goddard Space Flight Center, Greenbelt, Md.). Phys. Rev., 167: 1170-5(Mar. 25, 1968).

In the early high-density high-temperature universe, matter and antimatter are in equilibrium and exist in almost equal quantities. In a comoving element of volume the ratio of the baryon number ΔB to the number of baryons B is small. We must explain why initially there is a slight excess of matter over antimatter and why finally, after annihilation, matter is concentrated into objects of galactic size. By proposing that the initial conditions consist of spatial variations in the baryon number rather than variations in density (i.e., the number of baryons), we can link together the survival and aggregation of matter or antimatter as closely related subjects. Various topics are discussed, such as: the amplification of baryon compositional inhomogeneity $\Delta B/B$ is an expanding universe; the prestellar hadron, lepton, and radiation eras; the effect of inhomogeneity on final composition; the approximate constancy of the total number of particles (including photons) in a comoving element of volume; the muon-neutrino and electron-neutrino temperatures; and the required amount of initial baryon inhomogeneity. (auth)

22335 INVERSE-MASS APPROXIMATION TO THE SATURATION OF THE ALGEBRA OF AXIAL-VECTOR CURRENTS. Kazes, E. (Pennsylvania State Univ., University Park). Phys. Rev., 167: 1543-5(Mar. 25, 1968).

The axial-vector charge radius is calculated, assuming that the low-momentum-transfer behavior of the vector and axial-vector form factors is not greatly affected by transitions between continuum states (all states besides the nucleon). Within its range of validity this method can also be used to obtain a closed expression for the axial-vector form factor in terms of static nucleon parameters. (auth)

22336 CONSERVATION OF MOMENTUM AND ANGULAR MOMENTUM IN RELATIVISTIC CLASSICAL PARTICLE MECHANICS. Currie, D. G. (Northeastern Univ., Boston. Univ. of Maryland, College Park); Jordan, T. F. Contract AT(30-1)-3829. Phys. Rev., 167: 1178-9(Mar. 25, 1968). (NYO-3829-12).

For a classical-mechanical system of two particles, the conditions for Lorentz-invariant equations of motion are expressed in terms of relativistic momentum variables, and are shown to imply that neither the conventional total kinematic particle momentum nor the conventional total kinematic particle angular momentum is a constant of the motion unless the accelerations are zero. This is compared with a theorem of Van Dam and Wigner. (auth)

22337 ISOTOPIC INVARIANCE AND THE DIFFERENCE OF TOTAL CROSS SECTIONS AT HIGH ENERGIES. Azimov, S. A.; Arushanov, G. G.; Rasulkulov, M. S. (Inst. of Nuclear Physics, Tashkent). Izv. Akad. Nauk Uzb. SSR, Ser. Fiz.-Mat. Nauk, No. 6, 36-9(1967). (In Russian).

Previously I. Ya Pomeranchuk indicated that the difference of total cross sections of a particle a interacting with a particle C and particle a with antiparticle $\bar{C}$ would converge to zero when $E \to \infty$ (E energy).' However analysis of this hypothesis showed that the total cross sections of interactions $E \to \infty$ are not necessarily converging to constant values as it was formulated by I. Ya Pomeranchuk in (Zh. Exp. Teoret. Fiz. 34, 725, 1958). (R.V.J.)

22338 INTEGRATION OF THE SCHROEDINGER EQUATION IN IMAGINARY TIME. II. Goldberg, Abraham (Univ. of California, Livermore); Schwartz, Judah L. Contract W-7405-eng-48. J. Comput. Phys., 1: 448-53(Feb. 1967). (UCRL-14770-T (Pt.2)).

The investigation of numerical techniques for the integration of the time-dependent Schrödinger equation in imaginary time is continued with particular emphasis on those methods that can be generalized easily to several spacial variables. (auth)

22339 DIRAC MATRIX AND TENSOR ALGEBRA ON A DIGITAL COMPUTER. Levine, M. J. (Univ. of California, San Diego). Contract AT(11-1)-Gen-10. J. Comput. Phys., 1: 454-5(Feb. 1967). (UCSD-10P10-13).

A collection of subroutines which perform symbolic algebraic manipulations with provisions for the matrix and tensor algebra commonly encountered in the reduction of expressions describing the interactions of elementary particles is reported. The expressions to be processed are presented in a format closely approximating common notation. In this form, the output is conveniently usable in FORTRAN arithmetic statements for subsequent numerical work. Subroutines are available to perform the input and output of expressions and the collecting of terms. Multiple substitutions may be made with or without free tensor indices. Tensor-index contraction can be done with the option of distinguishing between covariant and contravariant quantities. Expressions involving products of Dirac matrices may be simplified by anticommuting these matrices and using the Dirac equation. It is possible to evaluate the trace of a product of Dirac matrices, and implied sums of the form $(\gamma_\mu \ldots \gamma_\mu)$ may be done. (J.F.P.)

22340 AXIOMATIC FIELD THEORY AND ALGEBRA OF CURRENTS. Kallosh, R. E. (Lebedev Inst. of Physics, Moscow). Z. Eksp. Teor. Fiz., 54: 656-65(Feb. 1968). (In Russian).

A condition for the validity of the algebra of currents which is expressed as a set of relations between the Schwinger terms of the equal-time commutator and quasi-local terms is derived in the axiomatic field theory. In this case a formally covariant representation of Schwinger and quasi-local terms by introducing a normal to the space-like surface is convenient. Using the relativistic covarance of the amplitude, the Schwinger terms can be expressed by derivatives over the normal of quasi-local terms. In the final analysis this makes it possible to write down the conditions for the validity of current algebra in axiomatic theory in terms of quasi-local terms only. The fulfilment of the obtained conditions in different models is discussed. (auth)

22341 DIPOLE-MOMENT OPERATOR AND CURRENT ALGEBRA. Kazes, E. (Pennsylvania State Univ., University Park). Phys. Rev. Lett., 20: 882-4(Apr. 15, 1968).

Since current algebra is completely characterized by the first-moment operator, its determination provides information about the family of particles on which such realizations are possible as well as giving some of their properties. It is described how to obtain systematically the first-moment operator, in general, and also a nontrivial solution in an idealized case is provided. (J.F.P.)

Electromagnetic

Refer also to abstracts 22368, 22418, and 22419.

22342 (CONF-670923) PROCEEDINGS OF THE 1967 INTERNATIONAL SYMPOSIUM ON ELECTRON AND PHOTON INTERACTIONS AT HIGH ENERGIES, STANFORD, CALIFORNIA, SEPTEMBER 5–9, 1967. (International Union of Pure and Applied Physics. Atomic Energy Commission, Washington, D. C.). 658p. CFSTI.

The conference included 24 papers five of which were abstracted previously in NSA. For abstracts of these papers see abstract numbers: 21: 46466, 22: 1403, 22: 5619, 22: 11569, and 22: 15660. Separate abstracts were prepared for 19 papers. (J.F.P.)

For abstracts of individual papers see: 21349, 21350, 22268–22278, 22290, 22311, 22343–22345, and 22437.

22343 (CONF-670923-, pp 109-27) THEORETICAL IDEAS ON INELASTIC ELECTRON AND MUON SCATTERING. Bjorken, J. D. (Stanford Linear Accelerator Center, Calif.).

A rapid review of routine items regarding inelastic electron and muon scattering is given. The knowledge of this process consists primarily of kinematics, such as the general form of the cross section, number of form factors, the limit of photoabsorption, the consequences of one photon exchange, and radiative corrections. Photoproduction mechanisms are considered for electroproduction. However, electroproduction is a function of one extra variable which is the mass $(-q^2)$ of the virtual photon. One can see how the phenomenon varies as q^2. Also the region is considered where q^2 is large (≥ 1 GeV^2) and where the inelasticity, namely the energy transfer to the nucleon from the electron, is several GeV. (J.F.P.)

22344 (CONF-670923-, pp 270-308) DIFFRACTION PRODUCTION. Pipkin, F. M. (Harvard Univ., Cambridge, Mass.).

The vector dominance model is examined, and it is shown how this model fits the available data. It is found that there seems to be very good evidence for the general features of the vector meson dominance model, although there are still problems concerning understanding of the ϕ and some aspects must yet be clarified. (J.F.P.)

22345 (CONF-670923-, pp 337-75) COMPARISON OF EXPERIMENTS WITH MODELS FOR PHOTOPRODUCTION. Harari, Haim (Weizmann Inst. of Science, Rehovoth (Israel)).

A review of the situation below photon energies of 2 GeV is given with emphasis on the processes $\gamma + N \rightarrow \pi + N$ and $\gamma + N \rightarrow \pi + \Delta$ (1236). Then the photoproduction of single pseudoscalar mesons at 2 to 16 GeV is considered. Finally, the photoproduction of neutral vector mesons and some associated processes are discussed. (J.F.P.)

22346 (ITF-67-52) ELEKTROMAGNITNYE FORMFAKTORY NUKLONOV V MODELI KVAZINEZABISIMYKH KVARKOV. (Electromagnetic Form Factors of Nucleons in the Model of Quasi-independent Quarks). Shelest, V. P. (Akademiya Nauk Ukrainskoi SSR, Kiev. Institut Teoreticheskoi Fiziki). 1967. 13p. (In Russian). Dep.

In the framework of the model of quasi-independen quarks with switched-off interaction the form of baryon electromagnetic current is obtained, which implies a relation between nucleon electric and magnetic form factors, confirmed by experiment. (auth)

22347 (JINR-E2-3715) TEST OF CROSS-SECTION SUM RULES FOR NUCLEON MAGNETIC MOMENTS. Levin, K. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics). 1968. 13p. Dep.

Considering forward Compton scattering by nucleons and deuterons and approximating the deuteron by the free nucleons above the pion production threshold, the three cross section sum rules for the nucleon and deuteron magnetic moments are combined in a relation containing only known constants and a low-energy integral which agrees with the predicted value. The result concerning the validity of the sum rules supports other tests by Gerasimov, Drell and Hearn and Pagels based on pion photoproduction data below 1 GeV. (auth)

22348 POLARIZATION OF ELASTICALLY SCATTERED GAMMA RAYS. Somayajulu, D. R. S.; Rama Rao, J.; Lakshminarayana, V. (Andhra Univ., Waltair, India). Nuovo Cim., 54B: 281-92(Apr. 11, 1968).

The polarization effects in Rayleigh scattering of 662-keV gamma rays from a 10.8 curie ^{137}Cs source are investigated using a conventional Compton polarimeter equipped with sum coincidence arrangements. The asymmetry ratios R for elastic scattering of polarized photons in scattering and orthogonal planes are determined at Rayleigh-scattering angles 45, 60, 75, 90 and 105°. The values of R are also estimated theoretically using the formulas of Franz and Brown and Mayers. The experimental values of R as well as the trend of their variation with the Rayleigh-scattering angle are found to be in agreement with the predictions of the theory of Brown and Mayers. (auth)

22349 CALCULATED SPECTRUM IN INVERSE-COMPTON-SCATTERED PHOTONS. Jones, Frank C. (Goddard Space Flight Center, Greenbelt, Md.). Phys. Rev., 167: 1159-69(Mar. 25, 1968).

An electron of a given energy moving in a monoenergetic isotropic radiation field is considered. The energy spectrum of the photons that are scattered by the electron was calculated both exactly and in a greatly simplified approximate form for astrophysical calculations. The approximation may be derived earlier by expanding the exact solution in a small parameter and keeping only the leading terms or by employing a simplifying physical approximation at the beginning of the calculation. The approximate spectrum is similar to one previously derived by Ginzburg and Syrovatskii, the principal difference being that the present one does not break down if $\hbar\omega_i E > (m c^2)^2$, where $\hbar\omega_i$ is the initial photon energy and E the electron energy. The astrophysical applications of our approximate spectrum are indicated by calculating the spectrum of photons scattered by electrons with an inverse-power-law energy distribution. (auth)

22350 THREE-PION DECAY MODES OF THE η MESON: IS T = 3 NECESSARY? Price, LeRoy R.; Crawford, Frank S., Jr. (Univ. of California, Berkeley). Contract W-7405-eng-48. Phys. Rev., 167: 1339-41(Mar. 25, 1968). (UCRL-17629(Rev.)).

Predicted values of the branching ratio $R = \Gamma(\eta \rightarrow 3\pi^0)/\Gamma(\eta \rightarrow \pi^+\pi^-\pi^0)$ anywhere between 1.6 and 0.7 are perfectly consistent with the Dalitz plot of 640 background-free η decays $\eta \rightarrow \pi^+\pi^-\pi^0$. These events were analyzed under the assumption of pure T = 1 final states with a complex matrix element that includes terms cubic in pion energies. To obtain low values of R, final-state interactions are needed. T = 3 is not needed. (auth)

22351 ROTATIONAL INVARIANCE OF MAGNETIC MONOPOLES. Peres, Asher (Univ. of Maryland, College Park). Phys. Rev., 167: 1449(Mar. 25, 1968).

The Schwinger quantization relation for magnetic charges, $g = n\hbar c/e$ (n integer), is derived by purely group-theoretic methods, from the combined requirements of rotational invariance and gauge invariance. No mention is made of the controversial "singular strings" of magnetic monopoles. (auth)

22352 KINEMATICS AND SATURATION OF THE SUM RULES AND INEQUALITIES FOR INELASTIC ELECTRON-NUCLEON SCATTERING. Gilman, Frederick J. (Stanford Univ., Calif.). Phys. Rev., 167: 1365-71(Mar. 25, 1968). (SLAC-PUB-357).

The kinematics, sum rules, and inequalities for inelastic electron-nucleon scattering are reviewed, with emphasis on the relations between the sum rules and inequalities and the assumptions needed in their derivation. What can be learned from the manner of saturation of the inequalities is discussed. Limits are put on possible modifications of the sum rules at large values of q^2 from what we already know at small values of q^2, and for $q^2 = 1$ BeV^2 it is shown that the inequality for electron scattering is roughly satisfied by summing over the inelastic scattering spectrum up to final hadron masses of 2 MeV. (auth)

22353 COVARIANT THEORY OF THE DISINTEGRATION OF THE DEUTERON BY PIONS AND PHOTONS AT HIGH ENERGY. George, D. J. (Stanford Univ., Calif.). Phys. Rev., 167: 1357-64(Mar. 25, 1968).

A covariant form of the Austern model of the disintegration of the deuteron is developed within the framework of relativistic perturbation theory. It is shown that the model reproduces the recent polarization and asymmetry measurements, but suffers from the same defects as the noncovariant calculations. (auth)

22354 PHOTOPRODUCTION WITH LINEARLY POLARIZED PHOTONS AS A TEST FOR CUTS IN THE ANGULAR MOMENTUM PLANE. Cooper, Fred (Harvard Univ., Cambridge, Mass.). Phys. Rev., 167: 1314-17(Mar. 25, 1968).

Two simple experimental tests are proposed for Regge cuts. They consist of looking at $s(d\sigma/dt)$ for the reactions $\gamma + N \rightarrow \pi^0 + N$ and $\gamma + N \rightarrow N^* + \pi^0$ as a function of s and φ_γ for fixed t, where φ_γ is the angle the polarization vector makes with the scattering plane. The behavior of $s(d\sigma/dt)$ at $\varphi_\gamma = 0$ determines whether cuts are present or not. (auth)

22355 MUON TRIDENTS. Tannenbaum, Michael J. (Harvard Univ., Cambridge, Mass.). Contract AT(30-1)-2752. Phys. Rev., 167: 1308-13(Mar. 25, 1968). (HUX-2752-33).

Under the assumption that muons are heavy electrons, the total cross section for muon tridents on lead is calculated for 12.0-BeV incident muons including the effect of exchange for identical particles in the final state; various differential cross sections are presented. The positron spectrum for 31.5 MeV electron tridents on copper is also calculated and found to agree with Criegee's experimental results. It is found that the entire effect of statistics is confined to a region of phase space where the two leptons of like charge in the final state have an invariant mass of less than 3.5 times their rest mass. (auth)

22356 RELATIVISTIC MODEL FOR ELECTROPRODUCTION OF NUCLEON RESONANCES. Walecka, J. D.; Zucker, P. A. (Stanford Univ., NCalif.). Phys. Rev., 167: 1479-98(Mar. 25, 1968).

A simple model was made to obtain some estimates of the inelastic form factors for electron excitation of the nucleons resonances. The model is covariant and gauge invariant, and satisfies

all the general requirements of the theory. It relies heavily on the lead of previous theoretical work on the form factor for the $\frac{3}{2}^+$, $\frac{3}{2}$ (1238-MeV) level. The basic idea is to take from experiment the knowledge of which nucleon states are resonant. Single-pion electroproduction is examined and the relevant multipoles are projected from a covariant, gauge-invariant set of graphs which are thought to play an important role as an excitation mechanism. The multipoles are then multiplied by a final-state enhancement factor which provides a resonance mechanism. Some theoretical justification is given for this procedure. If just the electron is detected, one measures the virtual-photon width for formation of the resonance, and the result contains the possibility that the resonance can decay into other channels than just $\pi + N$. Only the inelastic form factors are calculated. The individual contributions of the resonance levels are normalized to photoabsorption, where such data exist. π, ω, and N exchange are retained as an excitation mechanism, and the over-all contribution of the ω exchange is treated as a single parameter, with which all the existing inelastic-electron-scattering data are fitted. Two equally acceptable fits with quite different properties are found. The ω-nucleon coupling constant from the analysis in reasonable agreement with other determinations of this quantity. Form factors for all the nucleon levels up through 2650 MeV are presented out to momentum transfers of interest in the SLAC experiments. (auth)

22357 RESONANCES OF ANY SPIN IN PION PHOTOPRODUCTION AND NUCLEON COMPTON SCATTERING. Schiller, D. H. (Univ. of Timisoara, Rumania). Z. Phys., 211: 9-19(Mar. 12, 1968).

Describing the vertices by form factors and the propagators by their spectral representations, calculations are made of the contribution of the exchange diagrams $\gamma\pi \to M^j \to \overline{N}N$ and $\gamma N \to N^{j+\frac{1}{2}} \to \gamma N$ to the invariant and helicity amplitudes, for meson (M^j) and baryon ($N^{j+\frac{1}{2}}$) resonances of any spin (j integer ≥ 1) and both parities ($(-)^j$ and $(-)^{j+1}$). (auth)

22358 PROTON FORM FACTOR IN THE TIMELIKE REGION. Pfister, H. (Univ., Munich). Z. Phys., 211: 176-82(Mar. 19, 1968).

With the help of an exact inversion formula for the dispersion relation the proton form factor is calculated for the whole timelike region of momentum transfer till 7(GeV)^2 with an accuracy of at least 50%. The essential features (extrema and zeros) can even be given within 25%. The p-resonance can be seen at the correct position but there is no marked vector-meson-dominance. (auth)

22359 PHOTOPRODUCTION OF THE η MESON. Dar, A.; Weisskopf, V. F. (Massachusetts Inst. of Tech., Cambridge). Phys. Rev. Lett., 20: 762-4(Apr. 1, 1968).

A theoretical estimate is made of the cross section for the $\gamma + p \to \eta + p$ interaction in the particle-exchange picture. It is noted that if η production is dominated by ρ exchange, then its production on target nuclei with zero isospin should be strongly suppressed. (L.B.S.)

22360 QUANTUM PROCESSES IN A CONSTANT AND UNIFORM ELECTRIC FIELD. Narozhnyi, N. B. (Moscow Engineering-Physics Inst.). Z. Eksp. Teor. Fiz., 54: 676-88 (Feb. 1968). (In Russian).

A method is proposed for selecting the physical solution of the Dirac equation in a constant and uniform electric field. The solution is physical if it develops from the conventional plane wave with a positive frequency if the field is switched on adiabatically. The probability of the splitting of a neutral system connected by short-range forces with a constant and uniform electric field and the probability of production of an electron-positron pair as well as a pair of scalar particles by a photon in this field are obtained. It is shown that the probabilities of these processes in weak electric and magnetic fields are described by the same function of invariant parameters $f = e^2F_{\mu\nu}{}^*F_{\mu\nu}/2m^4$ and $x = \sqrt{e^2(l_\mu F_{\mu\nu})^2}/m^3$ which passes at $f \to 0$ into the probabilities of the corresponding processes in a crossed field. (auth)

22361 A POSSIBLE CHECK OF GAMOW'S TIME-DEPENDENCE OF THE ELECTRIC CHARGE THROUGH HIGH-PRECISION FREQUENCY MEASUREMENTS. Ferrari, E. (Univ., Rome. Istituto Nazionale di Fisica Nucleare, Rome). Nuovo Cim., 54B: 156-9(Mar. 11, 1968).

It was previously proposed that the square of the elementary electric charge e might increase with time proportionally to the age of the universe $e^2 = \gamma m_p^2\, t/\tau$ (1), where γ is the gravitational constant, m_p is the proton mass and τ is an elementary unit of time, obtained as the ratio λ/c, where c is the velocity of light and $\lambda \simeq 10^{-13}$ cm is an elementary length associated with the physics of strong interactions. It is pointed out that this effect can also be tested in suitably arranged laboratory experiments to be repeated at time intervals which are small with respect to man's lifetime. This can be achieved by exploiting the extreme accuracy which can be attained in the measurement of frequencies of electromagnetic waves. The principle consists in repeating the comparison of two em frequencies having a difference dependence on the electromagnetic charge e. It is shown that with measuring devices already in use one can detect a net effect from equation (1) if present. (J.F.P.)

22362 HIGH ENERGY PHOTOPRODUCTION WITHOUT CONSPIRACY. Amati, D.; Cohen-Tannoudji, G.; Jengo, R.; Salin, Ph. (CERN, Geneva). Phys. Lett., 26B: 510-12(Mar. 18, 1968).

A simple mechanism is proposed in order to explain the pronounced forward peaks in reactions which are likely to be dominated by pion exchange. A fit is done for π^+ photoproduction. (auth)

22363 VIOLATION OF A QUARK MODEL SUM RULE IN PHOTOPRODUCTION. Bialas, A. (Jagellonian Univ., Krakow. Inst. of Nuclear Physics, Krakow); Gula, A.; Muryn, B.; Zalewski, K. Phys. Lett., 26B: 513-14(Mar. 18, 1968).

A sum rule following from the quark model of photoproduction is shown to be strongly violated by the experimental data at 3 GeV/c. (auth)

22364 THEORY OF THE COMPTON EFFECT ON A MAGNETIC MOMENT. Kukanov, A. B.; Amer, A. A. Vestn. Mosk. Univ., Ser. III. Fiz. Astron., No. 2, 125-7(Mar.-Apr. 1967). (In Russian).

The scattering of polarized photons on a polarized Dirac particle which is initially at rest and possesses a particular magnetic moment μ_0 of the Pauli type is investigated. On first considering the case where the incident monochromatic beam of photons is completely elliptically polarized, a formula for the differential effective scattering cross section is derived by using perturbation theory and summing with respect to the final states of the magnetic moment. The results of an analysis of this equation are presented for two important partial cases. First if the incident photons are linearly polarized in the xy plane, the radiation scattered in this plane turns out to be completely linearly polarized in a plane perpendicular to the xz plane. The polarization for other orientations is discussed. Secondly, if the incident photons are circularly polarized, the radiation scattered along (against) the z axis is completely circularly polarized independent of the orientation of the magnetic moment. Radiation scattered along a direction not lying on the z axis is generally speaking, partially elliptically polarized. In particular, radiation scattered in the plane $\theta = \pi/2$ turns out to be either completely or partially linearly polarized. An expression for the differential scattering cross section is also derived for the case where the incident radiation is unpolarized. (TTT)

22365 PHOTOPRODUCTION AND REGGE BEHAVIOUR. Ball, J. S. (Univ. of California, Los Angeles); Jacob, M. Nuovo Cim., 54A: 620-38(Apr. 1, 1968).

After a general discussion of the consistency of Regge behavior in photoproduction the gauge-invariance constraints imposed on a Regge amplitude are analyzed. It is shown in particular that the pion-trajectory contribution is gauge invariant by itself in spite of the fact that elementary pion-exchange contribution is not. The near-forward and forward amplitude is obtained from the gauge-invariance conditions in the evasive and conspirational cases. (auth)

22366 THREE-POLE FORMULA FOR THE PROTON ELECTROMAGNETIC FORM FACTORS. Wataghin, V. (Stanford Linear Accelerator Center, Calif.). Nuovo Cim., 54A: 805-8 (Apr. 1, 1968). (SLAC-PUB-359).

An attempt is made to establish a relation between the empirical formula for the proton electromagnetic form factors as a function of the four-momentum transfer t and a physical model of the dispersion type with a linear combination of vector-boson resonance terms, considering first only the ρ^0, ω, and φ. A short account is given of the results obtained trying to fit the experimental data up to $-t = 25$ for $G_{Ep}(t)$ or $G_{Mp}(t)/\mu_p$ with a three-pole type formula. (L.B.S.)

22367 SOME ELECTROMAGNETIC POLARIZATION EXPRESSIONS. Csonka, P. (CERN, Geneva). Nuovo Cim., 54A: 809-12(Apr. 1, 1968).

Some of the expressions for the cross section of electromagnetic scattering of polarized particles with anomalous magnetic moments are given. The calculation is performed in the first Born approximation. The expressions given are valid for the electromagnetic scattering of any two spin-$\frac{1}{2}$ fermions. Special cases are considered, proton–proton and proton–electron scattering. (L.B.S.)

Weak

Refer also to abstracts 21793 and 22385.

22368 (JINR-E2-3730) SCALAR MESON WIDTHS. Miku, L. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics). 1968. 10p. Dep.

The widths of scalar mesons are evaluated in the approximation of soft-meson emission, assuming that the equal-time commutator between an axial charge and an axial divergence is proportional to scalar meson fields. (auth)

22369 (NYO-1932(2)-130) VECTOR MESONS AND HADRONIC CURRENTS. Wick, G. C. (Columbia Univ., New York). Jan. 1968. Contract AT(30-1)-1932. 26p. Dep. CFSTI.

The connection between spin-1 resonances in two- and three-pion systems and the electromagnetic interactions of hadrons is considered. A background is given, but all results are not reviewed. A simplified model in which protons, represented by a Dirac field interact with the electromagnetic field in the conventional way is discussed. In addition there is a neutral vector field representing the meson (ρ^0). This field is coupled to the current four-vector of the proton field in the same way as the electromagnetic field, only with a different coupling constant. (J.F.P.)

22370 DIFFICULTIES OF THE THEORY OF WEAK INTERACTIONS. Low, Francis E. Comments Nucl. Particle Phys., 2: 33-5(Mar.-Apr. 1968).

Examples of e-ν and ν-ν scattering and $K^0 \rightarrow \mu^+ + \mu^-$ and $K^+ \rightarrow \mu^+ + \nu$ decays are used to illustrate some difficulties of the original Fermi field theory and the intermediate vector boson theory. (L.B.S.)

22371 THE NEXT EXPERIMENTS ON NEUTRINOS. Ramm, C. A. Nucleus (Paris), 8: 503-8(1967). (In French).

The theoretical assumptions of the existence of the neutrino and its experimental verification are briefly outlined. The sources of neutrinos are indicated and their role in the comprehension of the structure of matter is discussed. The laboratory and proton synchrotron experiments at CERN on the neutrino are briefly outlined. The preparation for future experiments is discussed with respect to the detector and the neutrino beam. The work being done at other laboratories is briefly indicated. (J.S.R.)

22372 FIXED POLES AND COMPOSITENESS. Rubinstein, H. R.; Veneziano, G.; Virasoro, M. A. (Weizmann Inst. of Science, Rehovoth, Israel). Phys. Rev., 167: 1441-8(Mar. 25, 1968).

Using a perturbative model, the asymptotic behavior of weak amplitudes is studied, looking in particular for the existence of fixed poles. The weakly interacting particles are considered as either elementary or composite. The conclusions can be summarized as follows: The existence of fixed poles is model-dependent. In particular: (1) If both interacting particles are elementary, the usual fixed poles are found at $J = \sigma_1 + \sigma_2 - n$, $n \geq 1$, where σ_1 and σ_2 are the spins of the particles. (2) If the weakly interacting particles are composite, the amplitude is superconvergent (even being nonunitary) and there are no fixed poles, at least for $J \geq 0$. (3) In the case of photoproduction of a spinless composite particle, i.e., an amplitude with only one elementary particle with spin one, there is no fixed pole at $J = 0$. Considering that the elementary particle has spin σ, it is argued that the pole at $J = \sigma - 1$ disappears, while the ones at $J = \sigma - n$ with $n > 1$ may or may not exist, depending on the wave function of the produced hadron. The implications of the results, and in particular the limitations on the hypothesis of partially conserved axial-vector current are discussed. (auth)

22373 EFFECTS OF FINAL-STATE INTERACTIONS ON THE DECAY RATE ${}_{\Lambda}H^4 \rightarrow \pi^- + {}^4He$. Block, M. M. (Northwestern Univ., Evanston, Ill.). Phys. Rev., 167: 1381-2(Mar. 25, 1968).

The effects of final-state interactions on the hyperfine decay rate ${}_{\Lambda}H^4 \rightarrow \pi^- + {}^4He$ were calculated, using a recent measurement of the s-wave phase shift from elastic π-${}^4He$ scattering at 139 MeV/c. The repulsive nature of the s-wave interaction leads to a 21% lowering of the partial decay rate calculated by Dalitz and Liu using noninteracting (plane-wave) particles in the final state. A new total lifetime estimate $\tau({}_{\Lambda}H^4) = 1.75 \times 10^{-10}$ sec is made. (auth)

22374 RADIATIVE CORRECTIONS TO THE FERMI PART OF STRANGENESS-CONSERVING β DECAY. Abers, Ernest S. (Univ. of California, Los Angeles); Dicus, Duane A.; Norton, Richard E.; Quinn, Helen R. Phys. Rev., 167: 1461-78(Mar. 25, 1968).

In the V-A theory of weak interactions with coupling constant G, whether or not it is mediated by an intermediate vector meson, it is shown to order αG that the contribution of the vector hadron current to the Fermi part of the amplitude for β decay involving hadrons in the same isomultiplet is independent of the details of the strong interactions. This contribution to the radiative corrections to β decay has been re-evaluated, with results that agree in form with those obtained previously with the use of zero-order perturbation theory in the strong interactions. The contribution of the axial-vector current is evaluated approximately for various models of the strong interactions. These results are compared with the predictions of universality, and generally there is good agreement with the Cabibbo angle determined from K_{e3} decay. The factors which influence the cutoff dependence of the theory are discussed, and among other things, it is pointed out that with the neglect of certain "small" quantities, the ratio of the rates for μ cay and β deaay is cutoff-independent in the theory with an intermediate vector meson. The effect of Schwinger terms is studied, as well as the relationship between the cancellation occurring in the vector contribution to β decay and the cancellation in a Yang-Mills theory which occurs as a consequence of the Ward identity. (auth)

22375 ON THE THEORY OF THE MUONIUM MECHANISM OF DEPOLARIZATION OF μ^+-MESONS IN MEDIA. Ivanter, I. G.; Smilga, V. P. Z. Eksp. Teor. Fiz., 54: 559-70(Feb. 1968). (In Russian).

The equations are found and analyzed of the phenomenological theory of a purely muonium mechanism of meson(μ^+) depolarization. The residual polarization of the meson(μ^+) in a magnetic field arbitrarily directed with respect to the initial momentum of the meson(μ^+) is determined and the time dependence of meson(μ^+) depolarization in a perpendicular magnetic field is calculated. It is shown that at rates of electron spin relaxation in the muonium atom close to the characteristic superfine splitting frequency, the residual polarization does not depend practically on the strength of the applied perpendicular magnetic field, while it displays a strong dependence in a parallel field. In case of weak perpendicular magnetic fields, the formulas obtained indicate that two different patterns of behavior of muonium precession are possible for different values of the magnetic field. The total set of the results obtained makes it now possible to evaluate unambiguously on the strength of experimental data the role of the muonium mechanism in each specific case. (auth)

22376 INELASTIC NEUTRINO-LEPTON INTERACTIONS. Yakh'yaev, R. Sh.; Kasumov, Yu. M. (Shemakhinsk Astrophysical Observatory, Baku. Inst. of Physics, Baku). Izv. Vyssh. Ucheb. Zaved., Fiz., No. 12, 81-5(1967). (In Russian).

Neutrino (antineutrino) interactions with electrons and positrons resulting in muon production was studied using two-component and four-component neutrino theory. Formulas were obtained for the angular distribution of arbitrary polarized recoil muons in neutrino (antineutrino) interactions with a polarized target. (tr-auth)

22377 POSSIBILITY OF STRONG INTERACTIONS FOR THE INTERMEDIATE BOSON. Callan, C. G. Jr. (Harvard Univ., Cambridge, Mass.). Phys. Rev. Lett., 20: 809-12(Apr. 8, 1968).

A theory of strongly interacting W's is presented which maintains all the important features of the conventional theory for low-energy weak processes, while permitting significant deviations from them at high energies. The appearance of new physics at high energies seems an inescapable consequence of giving the W's strong interaction. A system comprising leptons, hadrons, and a single charged vector meson is described. The ν + p and $\bar{\nu}$ + p scattering amplitudes are considered. (J.F.P.)

22378 QUARK MODEL AND SOFT-PION EMISSION IN LEPTONIC DECAY OF MESONS. Nakagawa, M. (Australian National Univ., Canberra). Nuovo Cim., 54A: 723-35(Apr. 1, 1968).

It is shown that a simple dynamical quark model based on the lowest order perturbation theory reproduces the results of the current algebra-PCAC- technique for the leptonic decays of mesons. (auth)

22379 TWO NEUTRINOS OR ONE? Shishkin, G. V. (Inst. of Nuclear Power Engineering, Minsk). Dokl. Akad. Nauk BSSR, 10: 381-4(1966). (In Russian).

The cross section of weak four-fermion interaction is analyzed from the point of view of the possibility in principle of an experimental check of the component nature of the neutrino. Three groups of processes are examined: those with the participation of only an electron neutrino; with the participation of only a muon neutrino; and with the simultaneous participation of electron and muon neutrinos. It is concluded that the experimental study of the first two groups cannot give useful information on the component

nature of the neutrino. The third group could give useful information, but an experimental study of the processes $\nu + e^- \rightarrow \nu' + \mu^-$ requires proton beams with an intensity of 10^{14} and energies of 250 BeV. (ATD)

Strong (General)

Refer also to abstracts 21836 and 22377.

22380 (INR-P-868/VII/PH) ASYMMETRY MOMENTS OF ANGULAR DISTRIBUTIONS. Kielanowski, P.; Werle, J. (Institute of Nuclear Research, Warsaw (Poland)). 1967. 11p. Dep.

The conventional harmonic analysis of the experimental angular distribution function requires cumbersome integrations with suitable weight functions ($P_n(\cos\vartheta)$, $Y_m^n(\vartheta,\varphi)$, or $e^{im\varphi}$). A much simpler analysis of the experimental data with the help of asymmetry moments is proposed. It is shown that the value of a suitable asymmetry moment may be used as a parity or spin test. (auth)

22381 (JINR-P2-3691) GEOMETRICHESKAYA PROVERKA IZOTOPICHESKOI INVARIANTNOSTI ELEMENTARNYKH CHASTITS. (Geometrical Check of the Isotopic Invariance). Grishin, V. G.; Podgoretskii, M. I. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of High Energy). 1968. 6p. (In Russian). Dep.

Some possible experiments are considered for checking the isotopic invariance of strong interactions of elementary particles. (auth)

22382 $QQ\bar{Q}$ MODEL OF MESON-BARYON PROCESSES. Mitra, A. N. (Univ. of California, Los Angeles). Phys. Rev., 167: 1382-94(Mar. 25, 1968).

A $QQ\bar{Q}$ model of meson-baryon scattering and production of both positive- and negative-parity mesons is developed as a generalization of the "elementary meson" model proposed earlier by the authors. The model is based on the assumption that mesons are tighter structures than baryons, which allows the former to "see through" the latter, but not vice versa. The formalism allows the full inclusion of multiple-scattering effects within the meson-quark system via the $QQ\bar{Q}$ structure, and leaves scope for the inclusion of similar effects between the meson and the quarks in the baryon, as a second-stage process. The model is more restricted than the usual quark models (based on additivity), which in general enable correlations of meson-baryon, baryon-baryon, and baryon-antibaryon amplitudes. The model makes little use of dynamics, except for the method of "spectator functions" to calculate the amplitudes for the various processes in terms of residues at the appropriate poles of the relevant spectator functions. However, the possible uses of simple dynamical considerations are indicated, by which the larger amplitudes could be distinguished from the smaller ones. The amplitudes are evaluated in a two-stage process, the first step indicating the "SU(3) level" of predictions, involving only one spin-parity type at a time, while the second step gives SU(6)-type predictions which in principle connect mesons of different spin-parity assignments. For the negative-parity mesons (0^- and 1^-), the results are similar to those obtained by previous authors. However, the model provides, with no extra physical assumptions but considerably more algebraic manipulations, amplitude relations for the production of positive-parity mesons (0^+, 1^+, and 2^+) which, according to the quark picture, are structures of the form $^1P_1$ and $^3P_{0,1,2}$, and are expected to simulate mesons of the type B, A_1, and A_2 (and perhaps also the scalar mesons). (auth)

22383 QUARK-DIQUARK MODEL OF BARYONS AND SU(6). Lichtenberg, D. B. (Tel-Aviv Univ., Israel); Tassie, L. J.; Keleman, P. J. Phys. Rev., 167: 1535-42(Mar. 25, 1968).

A model in which a baryon can be regarded as a bound state of two particles has been generalized to be approximately invariant under SU(6). In the model, one of the constituent particles of a baryon can be regarded as a quark and the other particle can be considered as a tightly bound state of two quarks, or diquark. The quark is taken to belong to a six-dimensional representation of SU(6), while the diquark is taken to belong to a twenty-one-dimensional representation. With this model, which can be considered as a specific dynamical approximation to the three-quark model, the baryon medium-strong mass splittings are calculated beyond lowest-order perturbation theory. The model provides a mechanism for breaking the Gell-Mann-Okubo baryon-octet mass formula while breaking the baryon-decuplet equal-spacing rule by a smaller amount. (auth)

Strong (Baryon No. = 0)

22384 (ITF-67-51) ALGEBRA MEZONNYKH TOKOV V MODELI KVAZINEZAVISIMYKH KVARKOV S VYKLYUCHENNYM VZAIMODEISTVIEM. (Algebra of Meson Currents in the Model of Quasi-independent Quarks). Shelest, V. P. (Akademiya Nauk Ukrainskoi SSR, Kiev. Institut Teoreticheskoi Fiziki). 1967. 22p. (In Russian). Dep.

The model of quasi-independent quarks with switched-off interaction is considered. In the framework of this model, relativistic-invariant meson matrix elements are constructed and a current algebra is proved to take place in any order in the quark inverse effective mass. (auth)

22385 FIELD THEORY, PARTIAL CONSERVATION OF AXIAL-VECTOR CURRENT, AND KAWARABAYASHI-SUZUKI-RIAZUDDIN-FAYYAZUDDIN SUM RULE. Chen, T. W.; Pugh, R. E. (Univ. of Toronto, Can.). Phys. Rev. Lett., 20: 880-1(Apr. 15, 1968).

The notion of partially conserved axial-vector currents is formulated in a canonical Lagrangian formalism. It is shown that the Kawarebayashi-Suzuki-Riazuddin-Fayyazuddin sum rule is an immediate and simple consequence of Weinberg's first sum rule and of the natural assumption that the Lagrangian is a functional of the axial vector field. An axial-vector field that describes both spin-1 particles of mass m and spin-0 particles of mass μ is considered. An application to A_1 and π decay is given. (J.F.P.)

22386 CALCULATION OF $\pi-\pi$ PHASE SHIFTS. Tryon, E. P. (Columbia Univ., New York). Phys. Rev. Lett., 20: 769-73(Apr. 1, 1968). (NYO-1932(2)-132).

The problems associated with distant singularities in studies of once-subtracted dispersion relations for the $\pi-\pi$ partial-wave amplitudes are alleviated by subtracting each dispersion relation either twice or 1 times, whichever is greater. A method is presented for approximately solving the resulting dispersion relation when the S-wave scattering lengths are given. Scattering lengths predicted by Weinberg and by Schwinger are then used to calculate S-wave phase shifts for $E_{c.m.}$ up to 900 MeV. (L.B.S.)

22387 MULTINEUTRAL PRODUCTION IN PROTON-ANTIPROTON ANNIHILATION. Vandermeulen, J. (Univ., Liege). Bull. Soc. Roy. Sci. Liege, 36: 485-90(1967).

Antiproton annihilation in liquid hydrogen at rest produces an important proportion of pion states containing more than one neutral pion. These multineutral states are, in comparison with the other states, much more frequent than uncorrelated pion production would predict. The production of pseudoscalar and vector mesons—with subsequent strong or electromagnetic decays—is investigated theoretically, in the aim of relating the frequencies of the multineutral states to the frequencies of the states leading to configurations with well determined kinematical parameters. A set of simple rules applied to meson production yields a reasonable agreement between the predictions and the observations. (auth)

22388 GENERALIZED STRESS-ENERGY TENSOR, SPECTRAL FUNCTION SUM RULES, AND THE 2^+ MESONS. Joshi, G. C. (Univ. of Manchester, Eng.); Pande, L. K. Phys. Rev. Lett., 20: 816-19(Apr. 8, 1968).

Sum rules for the spectral functions associated with the propagator function for the generalized stress-energy tensor are derived. Saturation of these sum rules with 2^+ and other mesons is then considered. This leads to some new and interesting mass formulas, which are discussed. (auth)

22389 SUPERCONVERGENCE AFTER CONSPIRACY FOR BACKWARD $N\bar{N}$ SCATTERING. Rotelli, P.; Scanio, J. J. G. (Univ. of Chicago). Nuovo Cim., 54A: 813-15(Apr. 1, 1968). (COO-264-419)

An attempt is made to saturate the independent superconvergence relations which exist for backward $N\bar{N}$ scattering. (L.B.S.)

22390 TESTS OF SYMMETRY MODELS IN NUCLEON-ANTINUCLEON ANNIHILATION AT REST. Bettini, A.; Santangelo, R. (Univ., Padua. Istituto Nazionale di Fisica Nucleare, Padua). Nuovo Cim., 54A: 574-82(Apr. 1, 1968).

In the $\bar{p}$ annihilation at rest in hydrogen and deuterium the relative values of the total and partial probabilities were obtained for the singlet and triplet $\bar{p}p$ and $\bar{p}n$ states. The capture mechanism was assumed to go as explained in the text. The annihilation probabilities into two mesons are compared with the predictions of SU_{6w} and SU_3. Disagreement with SU_{6w} was found. In the case of SU_3 it was found that, besides the amplitudes of the octet, also that of the decuplet is required. (auth)

Strong (Baryon No. = 1)

Refer also to abstract 21930.

22391 (COO-264-421) SOFT PION PROCESSES. Nambu, Yoichiro (Chicago Univ., Ill.). Jan. 1968. Contract AT(11-1)-264. 21p. (CONF-680102-2; EFI-68-11). Dep. CFSTI.

From Meeting of the American Physical Society, Chicago, Ill.

A review is given of soft pion processes, that is, processes in which low-energy (compared to other particles in the reaction) pions are emitted, absorbed, or scattered. Low-energy theorems for pions, the soft-pion formula, and nonlinear chiral Lagrangian models and gauge fields are discussed. (J.F.P.)

22392 (INR-P-880/VI/PH) SHADOW ELASTIC SCATTERING IN THE MULTI-REGGE-EXCHANGE MODEL. Michejda, L.; Turnau, J.; Bialas, A. (Institute of Nuclear Research, Warsaw (Poland)). 1968. 10p. Dep.

Shadow elastic scattering in the multi-Regge-exchange model of Ohan et al. is estimated. The necessity of introducing the momentum-transfer-dependent phases is pointed out. (auth)

22393 (UCRL-17385) BARYON RESONANCES. Tripp, Robert D. (California Univ., Berkeley. Lawrence Radiation Lab.). Jan. 1967. Contract W-7405-eng-48. 253p. (CONF-670108-4). Dep. CFSTI.

From 4th Conference on Symmetry, Coral Gables, Fla.

A discussion of experimental results completed since September 1966 on baryon resonances is given. Also considered is the assignment of resonances to multiplets through the use of mass formulas and a critique of these assignments by means of a detailed comparison of various decay rates. (J.F.P.)

22394 ELASTIC SCATTERING OF PARTICLES AND NUCLEON STRUCTURE. Tolstov, K. D. Izv. Akad. Nauk SSSR, Ser. Fiz., 31: 1480-2(Sept. 1967). (In Russian).

Analysis of experimental findings showed that in the region of the diffraction peak elastic scattering of various particles (protons, pions and K mesons) on protons is satisfactorily described by a formula corresponding to the gaussian distribution of transverse-momentum components over the coordinate axes. The constancy of the mean transverse momentum during variation in the energy of protons and pions may be attributed to the constancy of the interaction region. It was concluded that the elastic scattering of particles on protons implies a discrete structure of the quantities p^2, which may be attributed to the presence of at least two interaction regions differing from each other by a factor of 2. In the 10- to 30-GeV energy range for protons, the small cross sections $d\sigma/dt$ emerge onto a "plateau" for the values of $p_\perp$ ranging at from 2 to 3 GeV/c. (JPRS)

22395 INELASTIC K-MESON SCATTERING BY NUCLEONS AND A QUARK MODEL OF ELEMENTARY PARTICLES. Rekalo, M. P. (Kharkov Inst. of Physics and Tech.). Ukr. Fiz. Zh., 13: 259-66(Feb. 1968). (In Russian).

In a quark model the amplitudes of inelastic processes $K^- + N \to Y + M$ are determined in terms of two types of quark amplitudes corresponding to the following processes: $\Lambda' + q' \to q' + \Lambda'$ and $\bar{p}' + p' \to \Lambda' + \Lambda'$. A comparison of the cross sections of the reactions $\pi^+ + p \to K^+ + \Sigma^+$ and $K^- + p \to \Sigma^+ + \pi^-$ shows that the annihilation quark amplitude may be neglected. The relations between the cross sections are compared with the experimental data for two values of K^--meson momenta: $p_k = 2.24-$ Bev/c and $p_k = 3.00-$ BeV/c. A pseudoscalar meson mixing angle may be determined by the comparison of cross sections of η- and X-production. (auth)

22396 NEW PHASE-SHIFT PARAMETRIZATION BASED ON A PHASE-SHIFT DISPERSION RELATION. Coulter, Philip W. (Univ. of California, Irvine). Phys. Rev., 167: 1352-6(Mar. 25, 1968).

The dispersion relation for the phase shift used by Ball and Frazer is generalized to include the effects of zeros and poles in the S matrix. For complex S-matrix zeros near the physical cut, one obtains a new parametrization for a resonant state. For $l = 0$, the usual Breit-Wigner phase shift is found. The method is easily extended to resonances in higher partial waves (in terms of two parameters for the case of pure elastic unitarity). The results are used to describe three partial waves in πN scattering: P_{33}, D_{13}, and P_{11}. Excellent agreement with the published P_{33} phase shifts is obtained by using our resonant form plus the integral over the inelastic cut. The inelastic contribution to the phase shift is small at low energies but becomes important for $E_L > 300$ MeV (E_L is the incident-pion kinetic energy). Inelastic effects in the D_{13} partial wave can account for almost all of the phase shift up to $E_L = 500$ MeV. A narrow resonance plus inelasticity gives a good fit to the phase shifts up to $E_L = 900$ MeV. Our fit to the P_{11} phase shift depends on the nucleon pole, the Roper resonance, a zero in the S matrix below the elastic threshold, and inelastic effects. A good fit to the low-energy phase shifts can be obtained only if one assumes large inelasticity above 1 GeV; however, the model does account for the qualitative behavior of the P_{11} phase shift. (auth)

22397 ARE THERE EQUAL-AMPLITUDE POINTS ON THE BACKWARD CONE? Sakmar, Ismail A. (Univ. of Western Ontario, London). Phys. Rev., 167: 1450-1(Mar. 25, 1968).

A search was made for at least three energies such that the invariant amplitudes A and B and their relative phase on the backward cone are the same for $\pi^+ p$ scattering. Certain relations between the energies and differential cross sections are obtained which have to be satisfied if such energies exist. (auth)

22398 HIGH-ENERGY FORWARD DOUBLE EXCHANGE PRODUCTION CROSS SECTIONS IN THE QUARK MODEL. Sebastian, K. J. (Univ. of Maryland, College Park). Phys. Rev., 167: 1523-6(Mar. 25, 1968).

Within the framework of the quark model an extended additivity assumption for products of quark amplitudes is used to obtain relations among some of the high-energy forward production cross sections for baryons belonging to the SU(3) octet and decuplet and mesons belonging to the vector meson octet. In all the reactions considered, more than one unit of strangeness or charge is exchanged between incident and outgoing particles. Several relations are derived with and without assuming SU(3) symmetry for quark scattering amplitudes. Of particular interest is that there are a few relations which do not require SU(3) symmetry for quarks. They are: $\frac{1}{4}\bar{\sigma}(K^-p \to K^+\Xi^-) = \bar{\sigma}(K^-p \to K^0\Xi^0) = \bar{\sigma}(K^-n \to K^0\Xi^-)$; $\frac{1}{4}\bar{\sigma}(K^-p \to K^+\Xi^{*-}) = \bar{\sigma}(K^-p \to K^0\Xi^{*0}) = \bar{\sigma}(K^-n \to K^0\Xi^{*-})$; $\frac{1}{4}\sigma(K^-p \to K^{+*}\Xi^-) = \sigma(K^-p \to K^{0*}\Xi^0) = \sigma(K^-n \to K^{0*}\Xi^-)$, where σ denotes the spin-averaged differential cross section in the forward direction. The last set of relations is only for the zero-helicity state of K^{+*} and K^{0*} produced in the forward direction. These are the relations which must be compared with experiment to decide whether the additivity assumption of products of quark amplitudes is valid in double exchange reactions, since SU(3) seems to be badly broken on the quark level, at least for elastic scattering. (auth)

22399 CURRENT ALGEBRA AND Ω^- HADRONIC DECAYS. Pham, X. Y.; Zaoui, R. (Institut de Physique Nucleaire, Orsay, France). Phys. Rev., 167: 1319-21(Mar. 25, 1968).

The parity-violating as well as the parity-conserving amplitudes for the decay of Ω^- into a $\frac{1}{2}^+$ (or $\frac{3}{2}^+$) baryon and a 0^- meson are discussed by using the current-algebra technique and other techniques commonly used with it. For the two pionic decay modes $\Omega^- \to \Xi^0\pi^-$ and $\Omega^- \to \Xi^-\pi^0$, the $\Delta I = \frac{1}{2}$ rule and a rough estimate $\tau(\Omega \to \Lambda K)/\tau(\Omega \to \Xi\pi) \sim \frac{1}{9}$ are obtained. Finally, a relation connecting the S wave of $\Omega^- \to \Xi^*\pi$ to the P wave of $\Omega^- \to \Xi\pi$ is obtained. (auth)

22400 CONSPIRACY RELATIONS IN VECTOR-MESON PRODUCTION. Frautschi, Steven; Jones, Lorella (California Inst. of Tech., Pasadena). Contract AT(11-1)-68. Phys. Rev., 167: 1335-8(Mar. 25, 1968). (CALT-68-142).

The conspiracy relations are listed for reactions of type $\Pi + N \to V + N$ and $\Pi + N \to V + \Delta$, emphasizing that there are relations connecting states with opposite parity at $t = 0$ even when all four masses are unequal. It is shown in detail that if the relations are satisfied by vanishing of the couplings of individual trajectories at $t = 0$, all helicity-flip amplitudes are suppressed at forward angles; whereas if the relations are satisfied by conspiracy among trajectories, the flip-flip amplitudes which conserve angular momentum in forward scattering can contribute with full strength. (auth)

22401 S-WAVE π^- + p SCATTERING AND A POSSIBLE η–n BOUND STATE. Pal, B. K. (National Physical Lab., New Dehli). Phys. Rev., 167: 1350-1(Mar. 25, 1968).

The π^- + p $T = \frac{1}{2}$, $J = \frac{1}{2}^-$ scattering length and phase shift are calculated in a coupled-channel model of π-N and η-N scattering. The η-n system is treated as a Regge pole associated with quasi-bound state. The Born terms associated with ρ and nucleon exchange are included in the calculation. The results are compared with experimental data. (auth)

22402 PRODUCTION OF BOSON RESONANCES IN THE MODEL OF QUARKS. Levin, E. M.; Frankfurt, L. L. (Ioffe Inst. of Physics and Tech., Leningrad). Z. Eksp. Teor. Fiz., 54: 652-5(Feb. 1968). (In Russian).

On the basis of the hypothesis of additivity of quark amplitudes in the scattering of high-energy adrons, relations are derived between the cross sections of production of hadrons with identical L and S but different J, as well as spin correlations are discussed. (auth)

22403 REGGION GRAPHS AND THE CONNECTION BETWEEN THE ASYMPTOTIC BEHAVIOR OF THE AMPLITUDE OF THREE-PARTICLE PRODUCTION WITH THAT FOR THE TWO-PARTICLE REACTION. Ansel'm, A. A.; Dyatlov, I. T. (Ioffe Inst. of Physics and Tech., Leningrad). Z. Eksp. Teor. Fiz., 54: 508-21(Feb. 1968). (In Russian).

The asymptotic behavior of Feynman graphs is considered for the amplitude of conversion of two particles into three at high energies and finite momentum transfers. All possible types of large asymptotes of these graphs are enumerated. These asymptotes are naturally brought in correspondence with the reggion graphs with two-dimensional integrations. It is shown that at small momentum transfers and under conditions when a comparatively slow particle moves nearly along the direction of movement of initial particles, the production amplitude proves to be independent of pair energies of particles and proportional to the two-particle amplitude. The result is just when a certain conserving quantum number is connected with the reggion with which particles are exchanged. Concrete examples of such reactions are given. (auth)

22404 PREDICTION FOR THE ΛKN AND ΣKN COUPLING CONSTANTS FROM AN ENERGY DEPENDENT FINITE ENERGY SUM RULE. Martin, A. D.; Ross, G. G. (Univ. of Durham, Eng.). Phys. Lett., 26B: 527-9(Mar. 18, 1968).

A finite energy sum rule for the K^+p forward scattering amplitude is used to obtain a prediction for the ΛKN and ΣKN coupling constants. The prediction is incompatible with SU(3) invariance. (auth)

22405 FINITE ENERGY SUM RULES AND THE CROSSOVER PROBLEM IN K–N SCATTERING. Di Vecchia, P. (CNEN, Frascati, Italy); Drago, F.; Paciello, M. L. Phys. Lett., 26B: 530-4(Mar. 18, 1968).

The behavior of the ω-residue functions in kaon-nucleon elastic scattering is studied using the "finite energy sum rules" technique. It is found that both spin flip and nonspin flip ω-residues show a zero near $t \sim -0.1$ $(GeV/c)^2$: this is in agreement with the usual explanation of the crossover phenomena in KN and NN elastic scattering, but in contradiction with the behavior of the ω-residue functions deduced from other reactions. (auth)

22406 MASS EIGENVALUE PROBLEM FOR BARYONS IN THE NONLINEAR SPINOR THEORY. Duerr, H. P.; Wagner, F. (Max-Planck-Institut fuer Physik und Astrophysik, Munich). Nuovo Cim., 54A: 639-94(Apr. 1, 1968).

In the past the determination of baryon masses in the framework of the nonlinear spinor theory of elementary particles was only carried out with a certain truncated form of the coupled equations of the lowest, nontrivial New-Tamm-Dancoff approximation, in which the mass eigenvalue determination reduced to a purely algebraic problem, limited to the spin-½ isospin-½ baryon case. The nontruncated NTD-equations are studied, which have the form of a coupled system of integral equations for 1- and 3-point baryon wave functions. With respect to the earlier, simplified treatment there arise two complications: Firstly, a purely algebraic complication, connected with the cumbersome, relativistic angular momentum decomposition of the wave functions and the corresponding integral kernels, and secondly an analytical complication, connected with the solution of integral equations instead of algebraic equations. The angular-momentum decomposition of the equations can be carried out exactly by making use of graphical techniques. The kernels of the resulting integral equations for the partial-wave amplitudes are in general 16 × 16 matrices with respect to the spin-isospin variables and can be expressed compactly by a certain combination of Wigner's 15j-symbols involving spin, and 6j-symbols involving isospin. Regarding their analytical structure they reveal themselves as kernels arising from an interaction of π, η, ρ, ω bosons (being established in the same approximation as S-wave bound states of the "nucleon-antinucleon" system) with a "nucleon" in various angular momentum states. The interaction contains spin-flip and nonspin-flip normal and exchange type terms and spin-orbit coupling terms. In an approximation in which the contributions of the virtual spin 1 bosons are neglected, the integral equations become much simpler, and have roughly the structure of a Bethe-Salpeter equation with (for $l > 0$) a pure mass-zero exchange force of the exchange type. The structure of these equations is investigated with respect to their isospin and angular momentum dependence. Since the solutions of a Bethe-Salpeter exchange equation (in contrast to the nonexchange type) with unequal masses of the constituents are not known (for equal masses of the constituents they can be reduced to the Wick-Cutkosky nonexchange case) at present only qualitative conclusions can be drawn regarding the baryon spectrum. A simple study of the signs of the various interaction terms seems to indicate that the structure of the equation is rich enough to produce, in principle, all essential features reflected in the empirical mass spectrum of strangeness zero baryon resonances. Hence a more detailed investigation of our integral equation seems very promising. (auth)

22407 SUPERCONVERGENCE AND BOOTSTRAP IN STATIC MODELS. Diu, B. (Laboratoire de Physique Theorique et Hautes Energies, Orsay, France). Nuovo Cim., 54A: 750-80 (Apr. 1, 1968).

A comparison between saturated superconvergence sum rules and bootstrap relations is carried out in static models. After a discussion on the possible meaning of superconvergence in such models, the analogy found in the πN case is shown to hold in more general situations. A number of important differences are however brought out by a more detailed investigation. In particular, the validity of the saturation approximation is seriously questioned: whether the relations it gives are satisfied seems to be independent, in these static models, of the convergence of the amplitudes. (auth)

22408 NEUTRAL-SCALAR-MESON THEORY IN THE STATIC LIMIT. Schlitt, D. W. (Univ. of Nebraska, Lincoln). Nuovo Cim., 54A: 563-73(Apr. 1, 1968).

The scattering of a neutral scalar meson from a spinless nucleon is investigated in the limit when the nucleon mass becomes very large in comparison with the meson mass. The calculation proceeds from the fixed momentum-transfer dispersion relation by expansion in a convergent power series. The expansions are restricted to small meson laboratory energy ω and small momentum transfer. It is found that even in the static limit the direct and crossed nucleon-pole terms cause S- and P-wave scattering to be equally important. This is in contradiction to the standard neutral scalar static model. The contradiction is resolved by noting that in the standard model the renormalized coupling constant vanishes; if this requirement is imposed the P-wave vanishes and the S-wave equation is the usual Low equation for the model. The relevance of these observations to earlier work of Barger and Kazes, Schlitt, and Huang and Low is discussed. (auth)

22409 MODEL FOR LOW-ENERGY KAON–NUCLEON SCATTERING. Ferreira, Erasmo M.; Lacaze, Robert (Centro Brasileiro de Pesquisas Fisicas, Rio de Janeiro). Notas Fis., Cent. Brasil. Pesqui. Fis., 13: No. 6, 139-45(1967).

An effective Lagrangian is proposed for K + N scattering. This Lagrangian does not include a possible direct exchange of S = +1 baryons, and limits the contributions of crossed terms to the Λ and Σ exchanges, neglecting isobar contributions. The values of S-wave scattering lengths, effective ranges, and p-wave scattering lengths are given. Attention is called to the fact that in this calculation there are no free parameters. From the results indicated it can be concluded that a pure vector meson exchange model describes the available data reasonably well. On the other hand by introducing Σ and Λ exchange together with the corresponding contact terms, although not affecting the S-wave scattering lengths, some of the smaller or less well-known parameters can be altered in an undesirable way. This may indicate that inclusion of contributions corresponding to Y_1^1 and Y_1^1 exchanges should be included when better data are available. (J.F.P.)

Strong (Baryon No. ≥ 2)

Refer also to abstracts 21929, 22297, 22353, and 22394.

22410 (JINR-P4-3714) O VYPOLNENII ZAKONOV SOKHRANENIYA V ELEMENTARNOM AKTE PRI RASCHETAKH VNUTRIYADERNOGO KASKADA. (On the Observance of the Conservation Laws in an Elementary Act at the Intranuclear Cascade Calculation). Sobolevskii, N. M.; Toneev, V. D. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics). 1968. 9p. (In Russian). Dep.

Simulation of inelastic πN and NN interactions when calculating the fast particle collisions with the nuclei by the cascade model involves some difficulties. One of them is an exact account of the laws of energy and momentum conservation when the characteristics of an elementary act are sampled from the known experimental angular and energy distributions of the produced particles. The problem is considered, in what degree the exact account of the law of energy conservation only (in the "equivalent" system) effects the elementary act characteristics and the results of calculation of inelastic nucleon-nucleus interactions. (auth)

22411 (SLAC-Trans-80) SUMMARY DATA ON SMALL-ANGLE p-p AND p-d SCATTERING AND THE REAL PART OF THE p-n SCATTERING AMPLITUDE IN THE 1 TO 10 GeV ENERGY RANGE. Dalkhazhav, N.; Devinski, P.; Zayachki, V.; (and others) (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of High Energy). Translated for Stanford Linear Accelerator Center, Calif., from report JINR-P1-3641. 22p. Dep. CFSTI. JCL $2.60 fs, $1.10 mf.

Tables are given for the differential cross sections of elastic p–p and p–d scattering in the 1 to 10 GeV energy range, also refined data on the magnitude of the real part of the amplitude of

p–n scattering in the 1 to 10 GeV energy range after an increase of statistics. The magnitude of the real part of the p–n scattering amplitude is calculated on the basis of the Glauber deuteron model. The experimental results are compared with predictions following from the dispersion relations and with relations for the scattering-amplitude derivatives for the point t = 0 flowing from the general principles of quantum field theory. The real part of the p–n scattering amplitude obtained in the reported experiment is compared with n–p charge-exchange data. (auth)

22412 EFFECT OF n–p TENSOR INTERACTIONS IN $^3H_\Lambda$ ON Λ–p SCATTERING PARAMETERS. Schrils, R.; Buxton, L. D. (Univ. of Kentucky, Lexington). Nuovo Cim., 54B: 267-80(Apr. 11, 1968).

Recent analyses of Λ–p scattering data are used to deduce ranges and depths for the Λ–nucleon triplet interaction. Variational calculations incorporating this information are then performed for the hypertriton with Hamiltonians which contain tensor components in the neutron-proton potentials. From the results of these variational calculations, properties of the singlet Λ–nucleon interaction are deduced. It is found that the inclusion of a tensor component in the neutron–proton interaction leads to differences of the order of 15% in the scattering lengths and 10% in the effective ranges when compared to equivalent calculations which do not include such tensor components. (auth)

22413 A NEW METHOD FOR THE ANALYSIS OF THE MECHANISM OF NUCLEAR INTERACTIONS. Dremin, I. M.; Zhdanov, G. B.; Tret'yakova, M. I.; Chernyavskii, M. M. (Lebedev Inst. of Physics, Moscow). Izv. Akad. Nauk SSSR, Ser. Fiz., 31: 1495-7(Sept. 1967). (In Russian).

It is shown that it is possible to use a method for the analysis of experimental data to represent on a single graph the entire totality of relativistically invariant quantities determined by the entire kinematics of the divergence of charged interaction products and to compare the individual event with a definite Feynman diagram. To this end the squares of 4-momentum transfer between two particle groups each of which includes a secondary nucleon are analyzed. Experimental findings are compared with Feynman's graphs on the assumption that the corresponding groups of secondary particles participate in the exchange of a virtual meson and hence also that the process is of a peripheral nature. It is shown that a reliable identification of the nature of interactions requires knowing both the results of direct measurements of each of the secondary nucleons and π^+ mesons and the information on π^0 mesons and particularly on those that entrain a large part of the energy (in the laboratory or mirror system). When the number of the mesons generated is large, however, only the angular distributions of the meson in a combination with the inelasticity coefficients of the nucleons can provide a graphic idea of the nature of the process. (JPRS)

22414 THREE-BODY ASSOCIATED PRODUCTION IN PROTON–PROTON COLLISIONS AND THE ONE-BOSON-EXCHANGE MODEL. Ferrari, E. (Univ. of Chicago. Univ., Rome); Serio, S. Contract AT(11-1)-264. Phys. Rev., 167: 1298-1308(Mar. 25, 1968). (COO-264-402).

The reactions pp → YKN are studied under the hypothesis of a dominant contribution from the exchange of a pseudoscalar meson (π or K) between the initial protons. The difficulty of a rigorous theoretical treatment of a true three-body final state is circumvented by assuming that the various damping effects at large momentum transfers (form factors, absorption) can be described in terms of a simple multiplicative cutoff function. Also, the assumptions and approximations which usually come into play in the theoretical analysis of these reactions are discussed critically. It is found that the agreement between theory and experiment is fairly good, within the limits of the model. (auth)

22415 THREE-PARTICLE SCATTERING: A REVIEW OF RECENT WORK ON THE NONRELATIVISTIC THEORY. Duck, Ian (Rice Univ., Houston, Tex.). Advan. Nucl. Phys., 1: 343-410(1968). (ORO-1316-35).

An exposition of recent work in three-particle scattering is given. The discussion is restricted to the nonrelativistic regime and almost exclusively to the three-nucleon problem, and comparison with experiment is emphasized rather than the formalism itself. The three-body bound-state problem is encountered only coincidentally as it occurs in the discussion of scattering. Recent successful calculations of low-energy neutron-deuteron elastic and inelastic scattering are primarily considered. (J.F.P.)

22416 NOTE ON THE EFFECTIVE RANGE APPROXIMATION FOR THE HULTHEN AND MORSE POTENTIALS. Eriksson, B. (Royal Inst. of Tech., Stockholm). Ark. Fys., 34: 49-57(1967).

The Hulthén and Morse potentials were analyzed in terms of the effective range method. Diagrams illustrate the relations between the various parameters characteristic of the effective range theory. The usual central two-nucleon potentials, those previously examined as well as the above two, are adjusted to reproduce the low-energy two-nucleon scattering data now accepted. (auth) (Sweden)

22417 MESON BREMSSTRAHLUNG MODEL TAKING PHASE SPACE INTO ACCOUNT. Mack, G. (Univ., Munich). Phys. Lett., 26B: 515-19(Mar. 18, 1968).

Kastrup's meson bremsstrahlung model is reconsidered. Energy–momentum conservation is taken into account following in part a proposal by Anderson and Collins. Good agreement with the experimentally observed inelastic final proton spectrum in proton proton collisions is obtained. Elastic pp cross sections can also be accounted for. (auth)

22418 POTENTIAL MODEL CALCULATION FOR COPLANAR AND NONCOPLANAR PROTON–PROTON BREMSSTRAHLUNG. Drechsel, D. (Catholic Univ. of America, Washington, D. C); Maximon, L. C. Phys. Lett., 26B: 477-9(Mar. 18, 1968).

The cross section for coplanar and noncoplanar proton–proton bremsstrahlung is calculated with Hamada–Johnston and Reid potentials. The results agree with experiments and show a rapid decrease as the kinematic limit for noncoplanarity is approached. (auth)

22419 COHERENT AND INCOHERENT PRODUCTION IN NUCLEI AND UNSTABLE PARTICLE CROSS-SECTIONS. Margolis, B. (CERN, Geneva). Phys. Lett., 26B: 524-6(Mar. 18, 1968).

Theoretical expressions for the coherent and incoherent production of particles in nuclei in the GeV energy range are presented. They are both found to be sensitive to the produced particle–nucleon total cross sections. Data for photoproduction of mesons ρ^0 are analyzed and the total ρ^0–nucleon cross section is deduced. The results indicate a very general method for getting unstable particle-nucleon cross sections. (auth)

Particle Invariance Principles and Symmetries

Refer to abstract 22591.

General

Refer also to abstracts 22445, 22474, and 22598.

22420 (PUC–937-304) GROUPS, SYMMETRIES AND QUARKS. PART I. GROUPS AND SYMMETRIES. Lipkin, Harry J. (Princeton Univ., N. J. Palmer Physical Lab.). Feb. 1968. Contract AT(30-1)-937. 34p. Dep. CFSTI.

The discussion of groups, symmetries, and quarks includes space-time and internal symmetries, some general remarks on the use of group theory in particle physics, and an example of how the pedestrian approach might be used in discussing the Lorentz group. A symmetry generator with explicit time dependence, G-spin in a simple time-dependent Lie algebra, the structure of G-spin multiplets, G-spin multiplets in Dirac spinor notation, mass spectra in spinor space, and larger time-dependent Lie algebras are also discussed. (J.F.P.)

22421 DYNAMICAL THEORY OF HADRONS AND LEPTONS. Kursunoglu, Behram. (Univ. of Miami, Coral Gables, Fla.). Phys. Rev., 167: 1452-61(Mar. 25, 1968).

An attempt is made to give a dynamical description of hadrons and leptons by the same wave equation, yielding different mass spectra for each. The wave equation in the six-dimensional representation of SU(3,1) leads to the following results: (i) mass spectra for spin-½ and spin-3/2 leptons (represented by orthogonal states) are obtained in the form of doublets, (ii) the equation can accommodate all the usual SU(3) multiplets of hadrons in the 36 and 216 and higher-dimensional reducible representations of SU(3,1), and (iii) the internal symmetry is induced by SU(3,1) parity doubling of the states as well as the SU(3,1) noninvariance of the wave equation. (auth)

22422 MIRROR RELATIONS AS NONDYNAMICAL TESTS OF CONSERVATION LAWS. Csonka, Paul L.; Moravcsik, Michael J. (Univ. of California, Livermore). Contract W-7405-eng-48. Phys. Rev., 167: 1516-22(Mar. 25, 1968). (UCRL-70052).

A mirror relation is defined as $L(x_a,y_b;z_c,w_d) = \eta L(z_c,w_d;x_a,y_b)$, with $\eta = +1$ or -1, where $L(x_a,y_b;z_c,w_d)$ is an observable

for an arbitrary four-particle reaction a + b → c + d, and x_a denotes the polarization state of particle a, etc. Invariances under the transformations P (space reflection), T (time reversal), C (charge conjugation), B (detailed balancing), and products of these, are considered. First, the types of reactions are listed which transform into themselves under any one of these transformations. The M matrix of these self-transforming reactions will therefore be restricted by the requirement of invariance under these transformations. This allows a study of the validity of a particular conservation law using one single reaction. The restriction on the M matrices of one kind of self-transforming reactions can be expressed very simply in terms of the requirement that the number of occurrences of each of the three unit vectors used to span the space of momenta be either even or odd throughout each term of the M matrix. Under the transformations T, PT, TB, TC, PTC, TCB, PTB, and PTCB, these restrictions are expressed in terms of the number of one of the unit vectors or in terms of the sum of the numbers of all three unit vectors. These transformations are considered as of the odd type. On the other hand, under transformations P, B, PB, PC, CB, and PCB, the restrictions are expressed in terms of the sum of the numbers of two unit vectors. These transformations are of the even type. Under transformations of the even type, about half of the observables identically vanish. It is then shown that mirror relations among all observables arise under any of the transformations of the odd type. On the other hand, the only reaction for which mirror relations hold for all observables as a result of the transformations of the even type is the reaction 0 + ½ → 0 + ½. The factor η for mirror relations for the odd type is shown to be $(-1)^{a_1}s$, where a_1 is the sum of the numbers of those types of unit vectors appearing in the observable that are involved in characterizing the restriction of that particular transformation on the M matrix of its self-transforming reaction. It is shown that in order to distinguish among invariances under the various transformations of the odd type, observables in the eee or ooo subclasses are useless, and the observables in at least two other subclasses must be measured in order to pick out unambiguously the transformation under which the reaction is invariant. As a by-product, the number of terms in the M matrix of a self-transforming, but otherwise arbitrary, reaction under any of the various transformations is derived, thus generalizing the results of a previous paper. (auth)

22423 GENERAL MASS FORMULA FOR THE NAMBU WAVE EQUATIONS. Hermann, Robert (Univ. of California, Berkeley). Phys. Rev., 167: 1318(Mar. 25, 1968).

The general form for the mass formula is described using Lie-group theory. (auth)

22424 CP-VIOLATING WEAK CURRENTS. Maiani, L. (Istituto Superiore di Sanita, Rome. INFN–Sottosezione Sanita, Rome). Phys. Lett., 26B: 538-41(Mar. 18, 1968).

A theory in which CP is violated through second class axial currents is discussed. These currents are given a suitable algebraic structure so to maintain the leptons–hadrons symmetry in leptonic processes. PC-violations are then described by a universal angle φ, to be determined from experiments. Implications for leptonic and nonleptonic processes are discussed. (auth)

22425 NONLINEAR LAGRANGIAN MODELS INVARIANT UNDER THE GENERALIZED CHIRAL GROUPS SL(4,C) AND SL(12,C). Gursey, F. (Middle East Technical Univ, Ankara); Chang, P. Phys. Lett., 26B: 520-3(Mar. 18, 1968).

Nonlinear Lagrangian models that generalize chiral π-N Lagrangians are presented. Exact SL(4,C) or SL(12,C) invariance holds respectively in the cases of no internal symmetry and SU(3) symmetry in the limit of zero meson masses. Mesons are SU(4) or SU(12) multiplets. (auth)

22426 ALGEBRAIC ANALOGUE OF ZEEMAN'S THEOREM. Teppati, G. (Univ., Palermo, Italy. Istituto Nazionale di Fisica Nucleare, Palermo, Italy. Univ., Turin). Nuovo Cim., 54A: 800-4(Apr. 1, 1968).

An investigation is made of the algebraic content of Zeeman's theorem, which states that the causality group C coincides with the Lorentz group $G_{n,1}$ for n ≥ 2. An attempt is made to prove a similar statement for any n ≥ 2 by means of algebraic methods only, using the basic notions of vector-space theory, lattice theory, and algebraic geometry. (L.B.S.)

Applications (Electromagnetic and Weak)

22427 DERIVATION OF MASS SPECTRUM AND MAGNETIC MOMENTS FROM CURRENT CONSERVATION IN RELATIVISTIC O(3,2) AND O(4,2) THEORIES. Barut, A. O.; Corrigan, Dennis; Kleinert, Hagen (Univ. of Colorado, Boulder). Phys. Rev., 167: 1527-34(Mar. 25, 1968).

It is shown that in the framework of the noncompact dynamical group theory, for every choice of the current operator in the representation space, the requirements of current conservation and universality of charge determine the relativistic mass spectrum. The most general currents linear in the algebra and linear in the momenta are investigated, and mass spectra of the form m = C(j + ½) in O(3,2), and of the form m = Cn or m = Cn(1 + a/n^2)^{½} in O(4,2), are derived with positive magnetic moments and with form factors in agreement with experiment. The freedom in the choice of currents, minimal or nonminimal, is discussed and compared with that which exists in the usual Lagrangian field theory. (auth)

22428 CP INVARIANCE AND THE RADIATIVE DECAY OF THE LONG-LIVED NEUTRAL K MESON INTO TWO PIONS. Hiida, Kichiro; Lee, Yee-yen (National Tsing Hua Univ., Hsinchu, Taiwan). Phys. Rev., 167: 1403-7(Mar. 25, 1968).

As a possible test to observe the effects of CP nonconservation, the radiative decay process $K_L^0 \to \pi^+ + \pi^+ + \gamma$ is discussed in detail. A method to find the effects is given by observing the dependences of the transition rate on the energy difference of the two pions and on the polarization of the γ ray. If CP nonconservation in the decay $K_L^0 \to 2\pi$ is due to the electromagnetic interaction of hadrons, the effects of the CP nonconservation on the radiative decay will be expected to be quite large. A rough estimate of the magnitude of the branching ratio of this process is also made. The arguments given here are easily adapted to the decays $K_L \to 2\pi^0 + \gamma$, $K_2^0 \to 2\pi^0 + \gamma$, and $K_2^0 \to \pi^+ + \pi^- + \gamma$. (auth)

22429 CP VIOLATION IN CURRENT–CURRENT MODELS. Chiu, Y. T. (Aerospace Corp., El Segundo, Calif.); Schechter, J. Contract AT(30-1)-3399. Phys. Rev., 167: 1345-9(Mar. 25, 1968). (NYO–3399-136; SU–1206-136).

The usual current-algebra techniques are used in two separate models for relating CP-violating effects in K → 2π decays with possible CP violations in ordinary and strange β decays. In the first model, one meson is removed from the K → 2π matrix element, and the resulting current-current spurion is saturated with a limited number of intermediate states. The second model is essentially that of Glashow, Schnitzer, and Weinberg. In this model, it is found that the CP-violating rate can be calculated in terms of the chiral-symmetry spectral-function sum rules. The CP-conserving rate, on the other hand, required the use of SU(3) spectral-function sum rules. It is found that (a) the leptonic CP violations appear to be quite small, (b) the ΔI = ½ CP-violating transitions do not seem to be suppressed by the usual ΔI = ½ dynamical mechanism, and (c) there is a (model-dependent) tendency for the nonleptonic CP violation to vanish in the limit of chiral symmetry. (auth)

22430 AN EVALUATION OF SEARCHES FOR C NONCONSERVATION IN ETA DECAY. Bazin, M. J. (Princton Univ., N. J); Goshaw, A. T.; Zacher, A. R.; Sun, C. R. Phys. Rev. Lett., 20: 895-8(Apr. 15, 1968).

It is considered whether previous experimental results on η decay are compatible with an electromagnetic C nonconservation of strength sufficient to account for the observed CP nonconservation in K_2^0 decay. The decays $\eta \to e^+ + e^- + \pi^0$, $\eta \to \pi^+ + \pi^- + \pi^0$, $\eta \to \pi^+ + \pi^- + \gamma$ are discussed. It is concluded that the experimental study of η decays as a test of the existence of a C-even electromagnetic current does not presently set any stringent limit on the strength of the resulting interaction. Assuming favorable phase factors one would still have to attain a precision of better than 0.1% in the experimental study of the asymmetry of $\eta \to \pi^+ + \pi^- + \pi^0$ or better than 1% for $\eta \to \pi^+ + \pi^- + \gamma$ to test with some degree of confidence the hypothesis of C-nonconservation in the electromagnetic decay of the η meson. (J.F.P.)

22431 REMARKS ON ISOSPIN SELECTION RULES AND CP-NONCONSERVING PHASES IN GLASHOW'S THEORY. Pati, Jogesh C. (Univ. of Maryland, College Park). Phys. Rev. Lett., 20: 812-15(Apr. 8, 1968).

It is pointed out that in theories of the type proposed by Glashow where CP nonconservation is attributed to phase angles between V,A currents, one obtains a simple explanation of the observed isospin selection rules for the CP-conserving and CP-nonconserving K → 2π amplitudes in terms of current algebra and soft-pion approximation provided that the phase angles for the strangeness-preserving and strangeness-changing currents are nearly equal or that they are both small. Since the former is known to be small it is suggested that the latter must also be small. This would require that CP-nonconserving effects must be finite, but consistently small everywhere and not just in $K_L \to 2\pi$ decay. (J.F.P.)

Applications (Strong)

22432 (PUC–937-294) QUARKS, SYMMETRIES, AND GROUPS: A SURVEY FOR PEDESTRIANS. Lipkin, Harry J.

(Princeton Univ., N. J. Palmer Physical Lab.). Jan. 1968. Contract AT(30-1)-937. 20p. (CONF-680110-1). Dep. CFSTI.

From 5th Conference on Symmetry Principles at High-Energy, Coral Gables, Fla.

The survey of quarks, symmetries, and groups covers symmetries at high energies, wrong symmetries, rules for the quark model, relativistic quark models, and properties of quarks. (J.F.P.)

22433 UNITARY STATISTICAL MODEL OF MULTIPLE PRODUCTION OF PARTICLES. Barashenkov, V. S.; Zinov'ev, G. M.; Mal'tsev, V. M. Izv. Akad. Nauk SSSR, Ser. Fiz., 31: 1502-4(Sept. 1967). (In Russian).

The concept of unitary symmetry of strong interaction is used to refine the statistical theory of multiple particle production: without detriment to the postulate of the statistical theory that a statistical equilibrium sets in in the interaction volume, the generated particles are regarded as members of multiplets of a unitary unimodular group of rank 2. Then the finite reaction channels are characterized by a specific number of meson singlets, baryon octets and vector and pseudoscalar meson octets, i.e., by the selection of the group-SU_3 multiplets whose representatives all are currently well-known experimentally; the proposed extension of the statistical theory of multiple particle production makes an allowance for the utilization of other group-SU_3 multiplets once these also become better-known. It is shown that such an extension gives a better fit between theory and experiment than the currently widely discussed quark models. (JPRS)

22434 CHIRAL SYMMETRY, SUPERCONVERGENCE, AND SUM RULES FOR SCATTERING AMPLITUDES. Narayan, D. S.; Saxena, R. P.; Srivastava, Prem P. (International Center for Theoretical Physics, Trieste, Italy). Phys. Rev., 167: 1379-80(Mar. 25, 1968).

Generalizing an idea that chiral symmetry is exact in an asymptotic limit, superconvergent sum rules are obtained for suitable combinations of scattering amplitudes. The predictions of the sum rules are compared with experiment. (auth)

22435 CHIRAL TRANSFORMATIONS. Schwinger, Julian (Harvard Univ., Cambridge, Mass.). Phys. Rev., 167: 1432-6(Mar. 25, 1968).

Chiral transformations are discussed phenomenologically, beginning with the known properties of the low-energy πN system. The treatment of $\pi\pi$ scattering emphasizes the ambiguity in the connection between mathematical structures and the physical π field. The unitary generalization of the meson chiral transformation is applied to the strong-interaction decay $\eta^* \rightarrow \eta + 2\pi$. The predicted energy asymmetry of the η is consistent with observation. (auth)

22436 QUARK MODEL CALCULATIONS OF MESON-BARYON SCATTERING. Chand, Ramesh (Wayne State Univ., Detroit). Phys. Lett., 26B: 535-7(Mar. 18, 1968).

In an SU(3) symmetric quark model, the high-energy scattering of pseudoscalar mesons with the baryons is investigated in the crossed t-channel. Under the assumption that the physical baryon octet is given by: 8 (physical) = $8' \cos\theta + 8 \sin\theta$, where $8'$ and 8 baryons arise from $3 \otimes \bar{3}$ and $3 \otimes 6$ respectively, good agreement is found between the experimental data and the quark model predictions for $\theta = 20°$. (auth)

Field Theories

Quantum Field Theory

Refer also to abstracts 22276 and 22277.

22437 (CONF-670923-, pp 32-47) SOME THEORETICAL ASPECTS OF QUANTUM ELECTRODYNAMICS. Yennie, D. R. (Cornell Univ., Ithaca, N. Y. Lab. of Nuclear Studies).

A presentation is given of some practical aspects of the radiative corrections in quantum electrodynamics, and the present situation in low-energy quantum electrodynamics and its possible implications are reviewed. (J.F.P.)

22438 (ITF-67-39) PROBLEMY NEEKVIVALENTNYKH PREDSTAVLENII KANONICHESKIKH PERESTANOVOCHNYKH SOOTNOSHENII V KVANTOVOI TEORII POLYA. (The Problems of Nonequivalent Representations of Canonical Commutation Relations in Quantum Field Theory). Astakhov, A. V.; Zav'yalov, O. I.; Sukhanov, A. D. (Akademiya Nauk Ukrainskoi SSR, Kiev. Institut Teoreticheskoi Fiziki). 1967. 27p. (In Russian). Dep.

A number of problems on nonequivalent representations of c.c.r. Haag's theorem, its consequences and mathematical aspects of the problem are discussed from a certain point of view. The difference between unitary and canonical transformations is considered as exemplified by quadratic-Lagrangian models. It is shown that when using nonequivalent representations of c.c.r., the canonical transformations in a usual Hilbert space can be extended to unitary ones in a nonseparable Hilbert space. The realistic of field theory describing the field renormalization is used to show that similar possibilities can be realized in the exact field theory as well. (auth)

22439 (ITF-67-40) PROBLEMA PERENORMIROVKI SKALYARNOGO POLYA V AKSIOMATICHESKOM I LAGRANZHEVOM FORMALIZMAKH. (The Problem of Renormalization of a Scalar Field in Axiomatic and Lagrangian Formalisms). Polivanov, M. K.; Sukhanov, A. D. (Akademiya Nauk Ukrainskoi SSR, Kiev. Institut Teoreticheskoi Fiziki). 1967. 23p. (In Russian). Dep.

The arbitrariness in the definition of various Green's functions is connected with account of the integral over a large circle in spectral representations. The relations between various Green's functions are found in renormalized and unrenormalized theories (with number renormalization). The corresponding results in axiomatic and Lagrangian formalisms are brought into agreement. It is shown how the arbitrariness of the Borchers type defining the Heisenberg field affects Green's functions. (auth)

22440 (ITF-67-42) NEKOTORYE PROBLEMY GAMIL'TONOVA I LAGRANZHEVA FORMALIZMOV V KVANTOVOI TEORII POLYA. (Some Problems of the Hamiltonian and Lagrangian Formalisms in Quantum Field Theory). Svechnikov, S. V.; Sukhanov, A. D. (Akademiya Nauk Ukrainskoi SSR, Kiev. Institut Teoreticheskoi Fiziki). 1967. 40p. (In Russian). Dep.

A number of problems of the Hamiltonian formalism, unsolved so far are solved by a modification of the latter. The Dyson images of Heisenberg operators are obtained in the pure renormalization model and in the exact pseudoscalar theory. The unitarity problem for the S-matrix ordinary form in renormalized theories and the problem of determining the powers of Heisenberg operators. Lehmann's class of theories as well as some other problems are discussed from the Hamiltonian point of view. (auth)

22441 (ITF-67-50) INTEGRAL REPRESENTATIONS IN THE EUCLIDEAN QUANTUM FIELD THEORY AND THEIR CONSEQUENCES IN RELATIVISTIC CASE. Gachok, V. P. (Akademiya Nauk Ukrainskoi SSR, Kiev. Institut Teoreticheskoi Fiziki). 1967. 36p. Dep.

Integral representations of the vacuum expectation values of the products of field operators with account for local commutativity and positive definiteness are considered. The existence of a positive measure generating vacuum expectations is proved with the help of a commutative algebra of operators of the field type constructed by the characteristic functional of the Euclidean quantum field theory. The integral representations are given in the Euclidean quantum theory, after which the representations are obtained by analytical continuation in the relativistic case. The integral expansions of the Wightman functional in elementary functionals are investigated. (auth)

22442 (JINR-P2-3731) MODEL POLEI LI. (A Model of the Lee Fields). Efremov, A. V. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics). 1968. 14p. (In Russian). Dep.

It is shown that, for the Lee fields of an arbitrary tensor and isotopic structure, the spectral condition leads to the absence of the scattering. For a special case of the vector fields S = 1. (auth)

22443 SELF-INTERACTING COMPLEX SCALAR QUANTUM FIELD THEORIES. Rosen, Gerald (Drexel Inst. of Tech., Philadelphia). Phys. Rev., 167: 1395-1402(Mar. 25, 1968).

Conditions for a local, essentially nonlinear, complex scalar field theory to admit vacuum, one-quantum, and two-quantum particle-antiparticle stationary states are derived with the Rayleigh-Ritz procedure for functionalities. It is shown that only so-called Class-A theories, for which the self-interaction energy density divided by the absolute value of the field squared is uniformly bounded for all values of the field, admit wholly acceptable one-quantum and two-quantum particle-antiparticle stationary states. The Class-A theories appear to be effectively linear, with no observable interaction between the two quanta in the case of the two-quantum particle-antiparticle stationary states. (auth)

22444 S-MATRIX CALCULATION VERSUS PERTURBATION CALCULATION IN QUANTUM ELECTRODYNAMICS. Wu, Alfred C. T. (Univ. of Michigan, Ann Arbor). Phys. Rev. Lett., 20: 773-5(Apr. 1, 1968).

It is pointed out that the S-matrix calculation by Chou and Dresden (Rev. Mod. Phys. 39: 143(1967)) does not reproduce the results of perturbation calculations of quantum electrodynamics. The perturbation calculation is repeated, and the discrepancy in the S-matrix approach is traced. (L.B.S.)

22445 GROUP STRAIGHT-LINE MOTIONS AND THE GEOMETRIC THEORY OF FIELDS. Konopleva, N. P.; Sokolik, G. A. (Scientific Research Inst. for Introscopy, USSR). Dokl. Akad. Nauk SSSR, 177: 302-5(Nov. 11, 1967). (In Russian).

The A_μ^q calibration fields were examined starting from the Gel'fand–Yaglom-type covariance equation, obtaining a covariant derivative by the commutation law. The geometric theory of the A_μ^q potentials which may be considered as the affine compendency of the internal space is studied with respect to the increase of the parametric indices. Establishing the basis of a single-structure algebra, the condition was set that the structure must be defined by constants which are antisymmetric to all indices. A derivation similar to spinors was obtained. The invariant convolutions exist for any arbitrary value, as it is included in the irreducible representation into which the straight product of the spinors may be decomposed. (TTT)

22446 NONUNIQUENESS OF THE CANONICAL FORMALISM IN THE PRESENCE OF AN INDEFINITE METRIC. Lukierski, J. (Univ. of Wroclaw). Nuovo Cim., 54A: 583-8(Apr. 1, 1968).

It is shown that in the Froissart model describing dipole ghosts, the canonical formalism (i.e., field equations + canonical commutation relations) and definition of the vacuum state are not sufficient to determine the field operator uniquely. The meaning of additional parameters describing different operator solutions of Froissart's set of field equations and canonical commutation relations is explained. (auth)

22447 ALGEBRA OF SPIN CURRENTS IN A SIMPLE MODEL. Bitar, K. M. (Yale Univ., New Haven). Nuovo Cim., 54A: 589-607(Apr. 1, 1968).

The algebra of spin currents introduced in a previous publication is tested in a field theoretical model leading to a favorable result in the perfect internal-symmetry limit. (auth)

22448 FOUNDATION OF FIELD THEORY IN FRIEDMAN'S SPACE. Kurdgelaidze, D. F. Vestn. Mosk. Univ., Ser. III. Fiz. Astron., No. 2, 100-3(Mar.-Apr. 1967). (In Russian).

Friedman space is inserted into a 5-dimensional plane space. In the case of space negative curvature the coordinates are described in terms of the 3-dimensional curvature of Friedman space. The Friedman space occupies only parts of the 5-dimensional space, namely, the surface which can be subdivided into the surface of a 4-dimensional sphere and a line. The trajectory of the free motion of a particle on this surface is considered, and equations giving the trajectory parameters as a function of the curvature are presented. The field theory on the surface is developed by differentiating these equations with respect to the elements of the trajectory s, and by taking into account the change in curvature along the particle trajectory. The Lagrangian function of this system is described, and the Schroedinger equation is written in standard form. This method can also be used to represent field theory in the case of ordinary, 4-dimensional Minkowski space. (TTT)

Gravitation and General Relativity

Refer also to abstracts 21796 and 22361.

22449 EFFECTS PRINCIPLE AND CHARACTERISTIC PARAMETER IN THE TETRAD FIELD THEORY OF GRAVITATION. Treder, H.-J. Monatsber. Deut. Akad. Wiss. Berlin, 9: 431-5(1967). (In German).

The effects principle and the characteristic parameter in the recently proposed tetrad field theory of gravitation, in which the Einstein equivalence principle is fulfilled and a far-parallelized Reimann space–time was defined by the gravitation, are derived. The existence of the characteristic parameter is proved. (J.S.R.)

22450 GRAVITONS AS GOLDSTONE PARTICLES. Treder, H.-J. Monatsber. Deut. Akad. Wiss. Berlin, 9: 427-31(1967). (In German).

The significance of considering gravitons as Goldstone particles with respect to the Riemann space–time is shown. (J.S.R.)

22451 UPPER LIMIT OF THE POSSIBLE SPIN-GRAVITATIONAL EFFECTS. Braginskii, V. B.; Slabkii, L. I.; Martynov, V. K. Vestn. Mosk. Univ., Ser. III. Fiz. Astron., No. 2, 122-4 (Mar.-Apr. 1967). (In Russian).

An attempt was made to detect a possible spin asymmetry of the gravitational interaction during polarization of ^{27}Al and ^{1}H nuclei in a sample consisting of a mixture of Al powder and vacuum grease. The nuclear magnetic resonance (NMR) line width δH for ^{27}Al($I = 5/2$) and for protons ^{1}H($I = 1/2$) in vacuum grease was 9.0 oersteds and 7 to 9 oersteds at relaxation times at 0.37 sec and 10^{-4} sec respectively. The measurements were carried on a specially made, highly sensitive vacuum balance. The inhomogeneity of the magnetic field did not exceed a value of $\Delta B/B = 2$ to 3×10^{-5} with a vertical displacement of ± 1 cm. A series of about 4000 measurements of a possible change in amplitude were carried out at various values of the magnetic fields H_0 and H_1. A slight change in amplitude was observed at $H_1 = 60$ oersteds, but this effect was assigned to a diamagnetic or paramagnetic interaction of the sample with the inhomogeneous magnetic field. Thus, it can be assumed that the possible spin gravitational effects do not exceed a value of $\Delta F/F = 6 \times 10^{-10}$ for ^{27}Al, and $\Delta F/F = 4 \times 10^{-9}$ for ^{1}H. This result can be considered as indirect confirmation of the strong principle of equivalence. (TTT)

22452 KERR METRIC, ROTATING SOURCES, AND MACHIAN EFFECTS. Hernandez, Walter C. Jr. (Goddard Space Flight Center, New York. Goddard Space Flight Center, Greenbelt, Md.). Phys. Rev., 167: 1180-5(Mar. 25, 1968).

In a recent paper, a method was given for constructing exact interior solutions which might serve as sources of the Kerr metric. Here the method is given again, but in simpler form, and an example of an interior solution is given in detail. Some properties of these solutions are discussed, including the shape, mass density, and rotation rates of the bodies described. It is proven that solutions of this type exist which describe uniformly rotating bodies at least up to second order in the angular momentum parameter b. In the final section, a discussion is given which indicates that strong gravitational fields plus high-rotational velocities can lead to correspondingly high-rotational inertial effects on the observer who is near or inside the body. These inertial effects also give some direct information about the rotation of the body. This enables us to prove that uniformly rotating rings of mass could not serve as sources of the Kerr metric. (auth)

22453 GENERATION AND DETECTION OF DYNAMIC NEWTONIAN GRAVITATIONAL FIELDS AT 1660 cps. Sinsky, J. A. (Univ. of Maryland, College Park). Phys. Rev., 167: 1145-51 (Mar. 25, 1968).

The very-near-zone dynamic Newtonian gravitational fields of an acoustically stressed cylinder are measured as a function of distance and azimuthal angle. The high frequency of 1660 cps is a new regime for gravitational technology, since previously measured gravitational interactions were static, as in the Cavendish experiment, or at tidal cycles per day. Results are in agreement with theory. (auth)

22454 NEW FORMULATION OF THE AXIALLY SYMMETRIC GRAVITATIONAL FIELD PROBLEM. Ernst, Frederick J. (Illinois Inst. of Tech., Chicago). Phys. Rev., 167: 1175-8(Mar. 25, 1968).

The field equations governing the gravitational field of a uniformly rotating axially symmetric source are reformulated in terms of a simple variational principle. The new formalism affords a concise unified derivation of the solutions discovered by Weyl and Papapetrou, and permits a simple derivation of the Kerr metric in terms of prolate spheroidal coordinates. More complex solutions are identified by applying perturbation theory. (auth)

22455 DEFINITION OF RENORMALIZED MASS IN CLASSICAL GRAVIDYNAMICS. Kraus, K. (Philipps-Univ., Marburg, Ger.). Z. Phys., 211: 107-12(Mar. 19, 1968).

In Einstein's theory of gravitation, energy and momentum of sufficiently regular systems can be defined either as space integrals of suitable densities, or alternatively as surface integrals of certain superpotentials. For singular fields, these definitions are in general not equivalent. This is shown explicitly for an electrically charged point particle (Reissner-Nordström metric). The first method produces, similar to classical electrodynamics, a divergent self-energy, whereas the second method gives a finite result, thus leading automatically to a renormalized mass. Perhaps quantized gravity might cause similar improvements of quantum field theory. (auth)

22456 PLANETARY PRECESSION IN GRAVITATION THEORY. Jackiw, R. (Harvard Univ., Cambridge, Mass.). Nuovo Cim., 54B: 11-25(Mar. 11, 1968).

A simple derivation of the general relativistic correction to planetary orbits is given, without explicit reference to Einstein's field equations. The calculation is compared to Schiff's investigation of the bending of light. Restrictions on the line element of curved space, which follow from the weak and strong equivalence principles are discussed. The weak equivalence principle and the weak field approximation are exploited to give a simple derivation

of the correction to planetary motion in the Brans–Dicke theory. (auth)

22457 SOME REMARKS ON THE MARZKE–WHEELER METHOD OF MEASUREMENT. Castagnino, M. (Univ. del Litoral, Rosario, Brazil). Nuovo Cim., 54B: 149-50(Mar. 11, 1968).

The geodesic clock defined using elements belonging to the general relativity theory without any connection with the atomic constitution of matter, fully according to the idea of Bohr and Rosenfeld, is considered. An alternative demonstration based on affine geometry is given. It is noted that the Marzke–Wheeler method fails in all theories with no vanishing torsion, and then one must return eventually to a clock depending on the atomic constitution of matter, which may be, in some way, included in the frame of these theories. (J.F.P.)

22458 GRAVITONS IN THE UNIVERSE. Boccaletti, D. (Istituto Nazionale di Fisica Nucleare, Bologna); De Sabbata, V.; Gualdi, C.; Fortini, P. Nuovo Cim., 54B: 134-44(Mar. 11, 1968).

In order to calculate the density of gravitons in the universe, various processes that can contribute to the production of gravitons are examined, and an estimate of the cross sections for their production by two photons that react in presence of a gravitational field is given. Also given are the cross sections for the inverse processes, that is for the destruction of gravitons. After having examined other processes of production, in particular the production by close binary systems of stars, it is found that in the case of the evolutionary universe, that is, in a universe with an age of $\sim 10^{18}$ s, the situation is far from equilibrium and the gravitons are still accumulating. At the present stage the mean density of gravitons in the whole universe seems to be $\sim 10^{-19}$ erg/cm^3. (auth)

22459 NEW FAMILY OF EINSTEIN SPACES. Carter, B. (Cambridge Univ., Eng.). Phys. Lett., 26A: 399-400(Mar. 23, 1968).

A new family of solutions of the Einstein-Maxwell equations (with Λ term) is presented, combining many well known but previously unrelated metrics, including the vacuum solutions of De Sitter, Kasner, Taub-N.U.T. and Kerr, within a single formula. (auth)

22460 SPHERICALLY SYMMETRIC PROBLEMS IN GENERAL RELATIVITY. Pachner, J. (Astronomical Inst., Prague). Bull. Astron. Inst. Czech., 18: 219-28(1967). (In Czech.).

A system of equations for spherically symmetric problems in the general theory of relativity is deduced in the most general and physically clearest form. The equations, without the cosmological term, are integrated in particular special cases and thoroughly discussed with regard to the occurrence of physical singularities. An analytical proof is given that there exists no static spherically symmetric closed world model wholly filled with matter exhibiting a positive pressure. Further it is shown that the pressure gradient eliminates the occurrence of singularities outside the center of symmetry during a collapse as well as in cosmology. The pressure gradient cannot stop the contraction of a spherically symmetric closed world model and convert it to a new expansion before all matter of the world has contracted to a single point. (JPRS)

22461 NONSTEADY-STATE SOLUTIONS OF NONLINEAR EQUATIONS OF A SCALAR FIELD. Shikin, G. N. Vestn. Mosk. Univ., Ser. III. Fiz. Astron., No. 2, 107-12(Mar.-Apr. 1967). (In Russian).

Nonlinear equations of a scalar field are considered without a mass term with a nonlinear term with respect to the derivative of the field function. The possibility of nonsteady-state solutions giving a finite value for the energy and momentum of the field, in other words, particle-like solutions, is investigated. Four types of equations obtained from four types of Lagrangian functions are considered: the Born-Infield type, two logarithmic functions of the Schroedinger type, and the type $L = L_0 + L_1$, where L_0 gives the equation for the free field, and L_1 gives the nonlinear terms in the field equation. On going to complex fields, each of the equations have a particle-like nonsteady-state solution. (TTT)

22462 CONVERSION OF VELOCITY AND ACCELERATION IN THE GENERAL THEORY OF RELATIVITY. Kiriya, V. S. (Tbilisi State Univ., USSR). Soobshch. Akad. Nauk Gruz. SSR, 43: 321-6(Aug. 1966). (In Russian).

According to the general principle of relativity, all systems of measurement are physically equivalent; consequently, any consideration of the problem of conversion of coordinates, velocities, and acceleration is beside the point. However, V. A. Fok established a new point of view on the general theory of relativity, according to which the equivalence of all systems of measurement is improbable. In work by Kiriya, et al., methods were developed for the conversion of Galilean measurements of plane space into Riemann measurements pertaining to space curved by a gravitational field (G-field). In accordance with the principle of equivalence, the formulas derived in that work can be regarded as effecting conversion from an inertial to a noninertial system of measurement (and vice versa), with the noninertial system being locally equivalent to some inertial system and a G-field. This approach contains an element of nonequality of the two systems: they are physically equivalent only in the absence of a G-field. Mathematical expressions for the conversion of velocity and acceleration are derived on the basis of this theory. Their application is illustrated in the example of hyperbolic motion. (ATD)

Scattering Theory

Refer also to abstracts 22330 and 22331.

22463 (ITEF–511) REDZHIONNAYA DIAGRAMMNAYA TEKHNIKA. (Regge on Diagram Technique). Gribov, V. N. (Gosudarstvennyi Komitet po Ispol'zovaniyu Atomnoi Energii SSSR, Moscow. Institut Teoreticheskoi i Eksperimental'noi Fiziki). 1967. 37p. (In Russian). Dep.

Based on the investigation of the Feynman graph asymptotic behavior at high energy and fixed momentum transfer the graph technique is formulated to consider the branch points in the angular momenta complex plane. Using this technique the reggeon is described as a nonrelativistic particle characterized by two-dimensional momentum k. The pole trajectory $\alpha(k^2)$ plays the role of energy and the momentum j – the role of frequency. The situation appears when describing the difraction cone assuming the existence of the Pomeranchuk pole is discussed. (auth)

22464 (LPTHE-TH-235) CROSSING RELATIONS FOR HELICITY AMPLITUDES IN PROCESSES WITH n FINAL PARTICLES AND THEIR IMPLICATIONS FOR THE MULTI-REGGE MODEL. Capella, A. (Paris Univ., Orsay (France). Laboratoire de Physique Theorique et Hautes Energies). Jan. 1968. 31p. Dep.

The crossing relations for helicity amplitudes are generalized to processes with n particles in the final state; these relations are obtained under the assumption that the spinor amplitudes are analytic in a domain big enough to allow crossing. The crossing relations turn out to be very similar to those for two-body processes. The consequences of the crossing relations for the multi-Regge model are analyzed, mainly in connection with the factorization principle. Applications are made to the study of decay angular distributions of resonances produced in such processes. (auth)

22465 UNUSUAL POSSIBILITIES FOR THE POMERANCHON. Schwarz, John H. (Princeton Univ., N. J.). Phys. Rev., 167: 1342-5(Mar. 25, 1968).

Two classes of unusual possibilities for the leading angular momentum singularities in vacuum quantum numbers are explored. The first class attempts to eliminate the need for an essential singularity at $J = 1$ by requiring the Pomeranchon to be a "self-reproducing" singularity. The second class attempts to implement a maximum-strength principle through a "colliding poles" mechanism. None of the models studied is believed likely to correspond to the actual situation. (auth)

22466 CONTINUATION IN COMPLEX ANGULAR MOMENTUM FOR A THREE-BODY EQUATION. Aaron, Ronald (Northeastern Univ., Boston); Teplitz, Vigdor L. Contract AT(30-1)-2098. Phys. Rev., 167: 1284-8(Mar. 25, 1968). (MIT–2098-374).

The particle bound-state scattering amplitude in Amado's three-body scattering model is continued in complex angular momentum for energies below the production threshold. The behavior of the leading trajectory in the left-half l plane is studied. It is shown that, as argued by Mandelstam, the "compositeness" of the bound state allows the trajectory to pass through $l = -1$ and $l = -2$. (auth)

22467 NEW CRITERION FOR NON-OSCILLATING HIGH-ENERGY BEHAVIOR OF SCATTERING AMPLITUDES. Gervais, J.-L.; Yndurain, F. J. (New York Univ., N. Y.). Phys. Rev., 167: 1289-97(Mar. 25, 1968).

A new definition of "non-oscillating" behavior at infinity is proposed which in fact allows for not-too-violent oscillations in the asymptotic region. Assuming that the absorptive part of the scattering amplitudes satisfies it, it is shown from dispersion relations that the whole amplitude does not oscillate, and from here is rederived in a general framework, the standard high-energy results, among them, Regge-type behavior (including signature), asymptotic equality of differential cross sections for A + B and

$A + \bar{B}$ elastic collisions, and the Pomeranchuk theorem, for a large class of scattering amplitudes. (auth)

22468 HIGH-ENERGY BOUNDS FOR PRODUCTION REACTIONS. Tiktopoulos, George; Treiman, S. B. (Princeton Univ., N. J. Phys. Rev., 167: 1408-11(Mar. 25, 1968).

Bounds on the high-energy behavior of multiparticle production reactions are set on the basis of high-energy properties thought to hold for elastic scattering reactions. The connection which is exploited for the purpose is provided by the principle of unitarity. Stronger results, which would follow from certain analyticity conjectures concerning the production processes, are also derived. (auth)

22469 USE OF ANALYTICITY IN THE CALCULATION OF NONRELATIVISTIC SCATTERING AMPLITUDES. Schlessinger, L. (Univ. of California, Berkeley). Phys. Rev., 167: 1411-23 (Mar. 25, 1968).

A new method of calculating nonrelativistic scattering amplitudes is presented. The scattering amplitude is first calculated as a function of the complex energy below the scattering threshold, and the numerical results are then analytically continued to the physical region. The method is used to calculate two-body and two-channel scattering amplitudes. The numerical analytic continuation is accomplished by a rational-fraction representation similar to the Padé method. Several techniques of numerical analytic continuation by rational fractions are described, and some examples are discussed. (auth)

22470 INVARIANT-AMPLITUDE APPROACH TO O(3,1) SYMMETRY OF REGGE TRAJECTORIES. Sawyer, R. F. (Univ. of California, Santa Barbara). Phys. Rev., 167: 1372-8(Mar. 25, 1968).

A simple method is given for constructing the leading terms which arise from the exchange of a single Lorentz pole [O(3,1) conspiracy of Regge poles] in the case of high-energy forward scattering of equal-mass particles. It is shown that some of the results may be taken over for the unequal-mass case; in particular, that the s^{α} term in forward scattering arising from an M = 0 conspiracy is pure spin-non-flip, while that from an M = 1 conspiracy is pure spin-flip. (auth)

22471 OFF-SHELL SOLUTION OF SCATTERING EQUATIONS. Brayshaw, D. D. (Rockefeller Univ., New York). Phys. Rev., 167: 1505-16(Mar. 25, 1968).

A method of solving scattering equations is discussed which enables one to exhibit explicitly the off-shell solutions. Results are derived for nonrelativistic scattering from superpositions of exponential and Yukawa potentials. As a byproduct, use is made of the representation for the partial-wave amplitude to prove meromorphy in the left half l plane, as well as giving simple derivations of some well-known results by Regge. The technique is easily generalized to other equations and potentials; in particular, the result obtained for the Blankenbecler-Sugar equation is stated. (auth)

22472 RELATIONS AMONG THE SUPERCONVERGENCE CONDITIONS FOR FORWARD ELASTIC SCATTERING. II. LINEAR RELATIONS AMONG THE CROSSED-CHANNEL HELICITY AMPLITUDES. Lin, Keh Ying (Cornell Univ., Ithaca, N. Y.). Phys. Rev., 167: 1499-1504(Mar. 25, 1968).

The relations among the superconvergence conditions for the forward elastic scattering of two particles with spin are discussed. Because of the existence of identities among the t-channel helicity amplitudes at t = 0, the corresponding superconvergence conditions are not independent. It is shown that there exists a set of t-channel helicity amplitudes with the following properties: (1) The corresponding superconvergence conditions are independent; (2) the superconvergence conditions for any other t-channel helicity amplitude are linearly related to the superconvergence conditions for this set of amplitudes. (auth)

22473 ANGULAR DEPENDENCE OF SCATTERING AT HIGH ENERGIES. Tiktopoulos, George; Treiman, S. B. (Princeton Univ., N. J.). Phys. Rev., 167: 1437-41(Mar. 25, 1968).

Experimental evidence indicates that for nonforward (and nonbackward) scattering angles θ, differential scattering cross sections fall off exponentially with increasing barycentric energy $\sqrt{s}$; namely, $d\sigma/d\Omega \sim_{s\to\infty} e^{-\phi(s,\cos\theta)}$, where $\phi(s,\cos\theta)$ is a positive quantity increasing as some power of s. From assumptions of boundedness and analyticity in $\cos\theta$, certain constraints on the $\cos\theta$ dependence of the exponent function $\phi(s,\cos\theta)$ are obtained. (auth)

22474 GROUP-THEORETIC APPROACH TO THE RELATIVISTIC THEORY OF SCATTERING. Roffman, Eric H. (Inst. for Advanced Study, Princeton, N. J.). Phys. Rev., 167: 1424-31(Mar. 25, 1968).

The representation theory of the complex inhomogeneous Lorentz group (CILG) is applied to an analysis of the relativistic S matrix. The kinematics and partial-wave analysis in the complex (s,t) plane are discussed in detail for two spinless particles. The connection with complex angular momentum is described. The reasons for believing that CILG is useful for the study of relativistic scattering, and an historical introduction to group-theoretical treatments of complex angular momentum, are also given. (auth)

22475 UPPER LIMIT FOR ELASTIC SCATTERING CROSS-SECTIONS AND THE RELATIONSHIP BETWEEN TOTAL CROSS SECTIONS AND S AMPLITUDE. Arushanov, G. G. (Tashkent State Univ.). Izv. Vyssh. Ucheb. Zaved., Fiz., No. 12, 86-9 (1967). (In Russian).

The upper limit for elastic scattering cross sections was obtained for elastic scattering of spinless particles with a small momentum transfer and arbitrary energies measured considering the total cross sections and the relation between the real and virtual forward scattering. The relation between the total cross sections and partial s-amplitude was also obtained. (tr-auth)

22476 THEORY OF MULTIPLE SCATTERING. III. Gnedin, Yu. N.; Dolginov, A. Z.; Tsygan, A. I. (Ioffe Inst. of Physics and Tech., Leningrad). Z. Eksp. Teor. Fiz., 54: 491-507(Feb. 1968). (In Russian).

The problem of multiple scattering of particles on a plane layer of matter is considered taking into account their slowing down in the process of scattering. A scattering intensity equation which coincides with the well known transport equation is obtained for the Schrödinger equation in the approximation $N_0 A^2 \lambda (1+\gamma)^2 \ll 1$ (λ is the particle wave length after scattering, A the scattering amplitude, N_0 the concentration of atoms of the scattering medium, and γ the ratio of the mass of the incident particle to that of the atom). The equation is solved in explicit analytic form for two cases: when the scattered particle energy E_1 is much lower than the initial energy E_0, and when the scattered particles lose a small part of the initial energy. In both cases it is assumed that the cross section is energy-independent. (auth)

22477 REDUCTION OF THE FADDEEV EQUATION. Riordan, F. (Univ. of Birmingham, Eng.). Nuovo Cim., 54A: 552-62 (Apr. 1, 1968).

The Faddeev equations are exactly reduced to multichannel two-particle Lippmann-Schwinger-type equations, the kernel of which is the solution of Faddeev equations with two-particle potentials too weak to produce bound states. This suggests a scheme of successive approximations of which the separable approximation is the first. (auth)

22478 MULTIPARTICLE AMPLITUDES AND THE SHEET STRUCTURE OF S-MATRIX SINGULARITIES. Jacobson, D. A. (Douglas Advanced Research Labs., Huntington Beach, Calif.). Nuovo Cim., 54A: 736-45(Apr. 1, 1968).

It is shown that a suggested procedure for determining the sheet structure of S-matrix singularities that do not intersect the physical region, by embedding the amplitude of interest as a factor in the residue of a higher multiparticle amplitude at single-particle poles, is not generally applicable. (auth)

22479 HIGH-ENERGY COLLISION THEORY. Tietz, T. (Univ. of Lodz, Poland). Nuovo Cim., 54A: 746-9(Apr. 1, 1968).

A generalization of the Molière approximation for the scattering amplitude $f(\theta)$ in high-energy collisions is considered. A new analytical expression for $f(\theta)$ is shown. All the considerations are based on the new WKB approximate solution of the radial Schrödinger equation finite at the turning points. (auth)

22480 ANGULAR MOMENTUM CONTINUATION FROM THE s-WAVE. Jones, R. B. (Queen Mary Coll., London). Nuovo Cim., 54A: 695-722(Apr. 1, 1968).

The question of the angular-momentum continuation of the radial wave function is considered in potential scattering theory. It is assumed that at a fixed value of l (s-wave) the radial wave equation can be solved for both the regular solution (wave function) and the irregular solution. From this knowledge an integral equation is constructed for the wave function which allows it to be analytically continued in angular momentum. Although the kernel of this integral equation is singular, the iterative solution is shown to exist in a limited region. An analysis of the spectrum of this kernel yields an interesting integral identity for the irregular solution of the wave equation. On the basis of this analysis an integral representation of the wave function (regular solution) is conjectured in terms of the irregular solution. For a limited class of potentials this representation is shown to hold in perturbation theory and to afford a view of all singularities in the left-half l-plane. (auth)

Particle Accelerators

Refer also to abstracts 21322, 21335, 22534, and 22607.

22481 (BNL-12307) OUTLINE OF A SIX-DIMENSIONAL PARTICLE MOTION PROGRAM WITH SPACE-CHARGE FORCES FOR LINACS. Chasman, R. (Brookhaven National Lab., Upton, N. Y.). Feb. 16, 1968. 15p. Dep. CFSTI.

A six-dimensional particle motion is described where the beam can have any shape and each particle is considered as a small sphere whose radius is determined by the nearby particle density. The space-charge force acting on a point in the beam is the sum of forces from all source spheres. This study attempts to incorporate the space-charge effects in a computer program describing particle motion. (W.H.K.)

22482 (CERN-563(Add.)) REPORT ON THE DESIGN STUDY OF A 300-GeV PROTON SYNCHROTRON. Addendum. Billinge, R.; Blewett, M. H.; Hardt, W.; Hine, M. G. N.; Lapostolle, P. M.; Moehl, D.; Montague, B. W.; Schnell, W.; Zilverschoon, C. J. (European Organization for Nuclear Research, Geneva (Switzerland)). May 30, 1967. 114p. (CERN-702; AR/Int.-SG-64-15). Dep.

Three injection systems are described including a 60-MeV linac with a 600-MeV TART and an 8-GeV booster; a 300-MeV linac and an 8-GeV booster; and a 200-MeV linac and a twin 8-GeV booster synchrotron. Also, experimental exploitations, the time schedule, manpower, and cost estimates are revised and updated. (W.H.K.)

22483 (CONF-650-14) TRANSVERSE BEAM BLOW-UP IN STANDING WAVE LINACS. Gluckstern, R. L. (Brookhaven National Lab., Upton, N. Y.). July 13, 1964. 18p. Dep. CFSTI.

From Linear Accelerator Conference, Stoughton, Wis., July 1964.

The build-up of deflecting modes due to two separate causes are calculated. The first is the nonresonant effect that comes from the deflection of the beam by the transverse fields already present. These deflections induce further transverse fields which have a component in phase with the original field. The second effect treated is the resonant build-up of the deflecting modes due to the transverse oscillations of the beam. The average displacement and angle of a beam bunch with respect to the longitudinal cavity axis induces a transverse field. Successive bunches can build up this field if there is a resonance between the transverse mode and one of the harmonics of the beam. Numerical computation of the combination of the two effects can also be performed. Estimates of the magnitudes of the two effects have been made for the AGS improvement program parameters. (W.H.K.)

22484 (INP-579/PL) ION FOCUSING PROPERTIES OF A DOUBLE MAGNETIC QUADRUPOLE LENS PAIR. Freindl, L.; Karcz, W. (Institute of Nuclear Physics, Krakow (Poland)). 1967. 18p. Dep.

A double magnetic quadrupole lens pair set used to focus nuclear particles from nuclear reactions is described. Experimental parameters of the lenses are compared with theoretical ones. Application of a quadrupole lens pair set in polarization measurements is discussed. (auth)

22485 (LA-3884) QUARTERLY STATUS REPORT ON THE MEDIUM-ENERGY PHYSICS PROGRAM FOR THE PERIOD ENDING JANUARY 31, 1968. (Los Alamos Scientific Lab., N. Mex.). Feb. 1968. Contract W-7405-eng-36. 36p. Dep. CFSTI.

Development of the 20-MeV electron prototype linear accelerator is discussed. Topics include rf power sources, control, instrumentation, experimental facilities, and accelerator physics. Also, LAMPF scheduling and facility construction are outlined. (W.H.K.)

22486 (LAL-1178) ETUDE DE LA FOCALISATION D'UN FAISCEAU D'ELECTRONS ULTRA-RELATIVISTES DANS UN ACCELERATEUR LINEAIRE. APPLICATION A L'ACCELERATEUR LINEAIRE D'ORSAY. (Study of Focusing a Beam of Ultrarelativistic Electrons in a Linear Accelerator. Application to the Orsay Linear Accelerator). Ah-Hot, L. M. (Paris Univ., Orsay (France). Laboratoire de l'Accelerateur Lineaire). 1967. 83p. (In French). Dep.

Thesis.

Focusing a beam of ultrarelativistic electrons in a linear accelerator was studied. This study made it possible to analyze a complex of problems connected with the natural divergence of the electron beam. These problems are resolved by the adaptation concept in the phase space of the admittance and the maximum possible emittance. This leads to the study of adequate accelerating lengths and focusing systems to minimize particle losses from the first optical element. These results were applied to the Orsay Linear Accelerator. The actual evolution of the beam in the quadrupole optics is calculated, and the effects of aberrations are determined theoretically. The results obtained experimentally are compared with the theoretical predictions. (J.S.R.)

22487 (NP-17329) LES DOCUMENTS DU CERN RELATIFS AU PROBLEME GENERAL DE L'EJECTION: BIBLIOGRAPHIE. (CERN Documents on the General Problem of Ejection: Bibliography). Fronteau, J. (European Organization for Nuclear Research, Geneva (Switzerland)). 1967. 44p. (DIR/PS/Int.-S-67-1). Dep. CFSTI.

A list of 293 documents on beam transport and extraction for the CERN synchrotron, synchrocyclotron, the proposed 300-GeV proton synchrotron, and the proposed intersecting storage rings is presented. (W.H.K.)

22488 (ORNL-4219, pp 110-13) SUPPORT FOR THE HIGH-VOLTAGE ACCELERATOR PROGRAM. (Oak Ridge National Lab., Tenn.).

Topics discussed include duoplasmatron ion source development, liquid-cooled Faraday cup, new cross-field analyzer for the 5-MeV Van de Graaff accelerator, remote pulse-monitoring oscilloscope for the pulsed tandem accelerator, subnanosecond pulsing of the tandem Van de Graaff accelerator, and large thin-wall scattering chamber. (W.H.K.)

22489 (ORNL-4219, pp 114-15) SUPPORT FOR LINEAR ACCELERATOR DEVELOPMENT. (Oak Ridge National Lab., Tenn.).

Progress on the ORELA project is reported. Also, a fast coaxial cup is described which was designed to monitor the fast beam pulse from ORELA. (W.H.K.)

22490 (SLAC-80) TWO-MILE ACCELERATOR PROJECT. Quarterly Status Report, January 1-June 30, 1967. (Stanford Linear Accelerator Center, Calif.). Jan. 1968. Contracts AT(04-3)-400; AT(04-3)-515. 124p. Dep. CFSTI.

A status report on the Stanford Linear Accelerator Project covering the period January 1, 1967 to July 1, 1967 is presented. Topics included are accelerator and research area operations, accelerator and research area equipment development, and physics research equipment development. (B.G.D.)

22491 (SLAC-PUB-386) ION LOSS BY ELECTRON SCATTERING IN COMPRESSED ELECTRON RINGS. Helm, R. H. (Stanford Linear Accelerator Center, Calif.). Feb. 1968. 6p. (CONF-680111-1). Dep. CFSTI.

From Conference on Stability of Electron Rings, Berkeley, Calif.

The heating by electron scattering on the ions trapped in a compressed electron ring can in principle lead to ion energies sufficient to permit escape from the potential well. A correct treatment of this question presumably would include the effects of random and systematic fluctuations in electron density, in which many particles might act collectively in exciting the ions. The purpose of the present note is to investigate the much simpler problem in which the ring is assumed to be uniform and quiescent, and the scattering events are assumed to be random and uncorrelated. Three separate processes are considered: single scattering, in which the recoil from one large-angle scattering event imparts escape momentum to the ion; azimuthal drag, in which the recoils from many small-angle events result in a cumulative tangential acceleration of the ions; and random walk, or statistical accumulation of impulses normal to the electron velocity. Under typical conditions for the electron ring accelerator (ERA) these processes all lead to insignificant losses of protons (lifetimes much greater than one second). In the case of highly ionized heavy ions, the random walk and azimuthal drag effects could have lifetimes on the order of the ionization time. (auth)

22492 STABILITY OF STRONGLY CHARGED PARTICLE BEAM IN A SYSTEM OF SHORT QUADRUPOLE LENSES. Shpak, E. V.; Yavor, S. Ya. (Inst. of Physics and Tech., Moscow). Radiotekh. Elektron., 13: 82-8(Jan. 1968). (In Russian).

Charged particle beam stability in a system of short quadrupole lenses separated by field-free intervals was studied taking into account the beam space charge. (tr-auth)

22493 THEORY OF ELECTROSTATIC FOCUSING OF INTENSE CHARGED PARTICLE BEAMS. Syrovoi, V. A. Zh. Prikl. Mekh. Tekh. Fiz., No, 4, 3-13(July-Aug. 1967). (In Russian).

The problem of determining electrodes for the formation of intense charged particle beams is mathematically reducible to the solution of a Cauchy problem and a Laplace equation. An algorithm for an analytical solution is presented which may also be applied

in a three-dimensional case. It is assumed that the boundary of the beam coincides with the coordinate surface $x^1 = 0$ of a certain orthogonal system $x^i (i = 1,2,3)$. The solution is presented in the form of a series for x^1 with coefficients depending on x^2, x^3 determined from recurrence relationships. As examples, a study is made of problems of the formation of beams with an elliptic transverse cross-section: 1) with periodic variation of the velocity z-component; 2) a case of nonmonotonal variation in the potential in a one-dimensional flow between planes z = const; 3) a beam accelerated in accordance with the $^3/_2$ law. In formulating the expansions, the boundary conditions are already satisfied by the two first terms of the series. (ATD)

22494 I. PRODUCTION OF STRONG PULSED MAGNETIC FIELDS FOR EXPERIMENTS ON HIGH-ENERGY PARTICLE ACCELERATORS. II. HEAT RELEASE AND MECHANICAL STRESSES IN PULSED MAGNETIC FIELD COILS. Barkov, L. M.; Khakimov, S. Kh.; Ogurtzov, V. V. (Kurchatov Inst. of Atomic Energy, Moscow). pp 409-15 of Les Champs Magnetiques Intenses, leur Production et leurs Applications. Paris, Centre National de la Recherche Scientifique, 1967.

From International Colloquium on Intense Magnetic Fields, their Production and their Applications, Grenoble, France. See CONF-660921.

In the first part pulsed magnetic field coils, Bitter type of large dimensions, for producing fields up to 230 kOe for nuclear physics experiments about elementary particles are described, and in the second part the distribution of temperatures and internal strains due to electrodynamical strains, thermal expansion deformation, and inhomogeneous distribution of temperatures, on these Bitter-type pulsed magnetic field coils are calculated. (auth)

22495 INFLUENCE OF THE OUTER MICROWAVE SOURCE ON THE STABILITY OF A CURRENT PULSE IN A LINEAR ACCELERATOR. Vishnyakov, V. A.; Zykov, A. I.; Grizhko, V. M.; Grishaev, I. A. Zh. Tekh. Fiz., 37: 1915-16(Oct. 1967). (In Russian).

The effect of the outer microwave source, parasitic oscillations, in the shortening of current pulses in the linear accelerator, was investigated. It was shown that under output conditions above 10^{-8} W the shortening of current pulses begins with the smallest value of the threshold current. The dependence of the shortening of the pulse on the generator frequency was investigated. (tr-auth)

22496 SUPERCONDUCTING CYLINDRICAL DIAPHRAGMED RESONATOR FOR THREE-CENTIMETER WAVE. Khristenko, E. V.; Dmitriev, V. M.; Mende, F. F.; Churilov, G. E. (Physical-Technical Inst., Kharkov). Zh. Tekh. Fiz., 37: 1852-4 (Oct. 1967). (In Russian).

A superconducting cylindrical diaphragmed resonator with variable phase velocity, operating on waves of the $\pi/2$ type, was described. The resonator was prepared from lead without welds or seams. The natural quality of the resonator is 2.4×10^8 at 4.2°K and 4×10^8 at 2°K. (tr-auth)

22497 IRREGULAR ENERGY DISTRIBUTION OF ACCELERATED ELECTRON BEAMS. Collin, J. E.; Magnee, A. (Univ., Liege). Bull. Soc. Roy. Sci. Liege, 36: 522-32(1967). (In French).

An experimental study of energy relaxation processes in accelerated electron beams used in electron guns has been undertaken. It is shown that the main perturbing factors affecting the electron energy distribution are the current density, the accelerating voltage and, accessorily, the Wehnelt potential of a space-charge limited gun. A new specific relation is proposed for the calculation of the relaxation effects and is compared to that previously proposed by Hartwig and Ulmer. It is also concluded that these phenomena are likely to be of secondary importance for the study of electron impact ionization efficiency curves. (auth)

22498 CONSTRUCTION OF ML-300 ELECTRON LINAC FOR TOHOKU UNIVERSITY. Hashimoto, Shinzaburo; Takabe, Toshio (Mitsubishi Electric Corp., Japan). Mitsubishi Denki Lab. Rep., 42: 347-54(Feb. 1968). (In Japanese).

ML-300 electron linac built and delivered to Tohoku University is designed to be used for a wide range of study in physics, chemistry, and medicine including nuclear experiment. It has the highest beam energy of 300 MeV and output current of 350 mA. Erection plan, setup of machines, control of cleaning and wiring work, construction, and general development are discussed. (auth) (NSA of Japan)

22499 ML-5A ELECTRON LINEAR ACCELERATOR. Toda, Tetsuo; Irie, Koichi (Mitsubishi Electric Corp., Japan). Mitsubishi Denki Lab. Rep., 42: 355-61(Feb. 1968). (In Japanese).

A ML-5A electron linear accelerator is provided with a HEM_{11} mode suppression type accelerating structure, and its input and output couplers employ a cavity type. The accelerating structure is built by a brazing method and squeeze is applied to the cavity to effect tuning and improve the mechanical accuracy of the accelerating structure. A constant phase velocity-type buncher is used. A triode electron gun with grid is used. The maximum emission current is above 5 A and it is possible to generate a short pulse beam to the extent of 10^{-9} sec. The maximum energy is 8 MeV. The maximum current is 1.3 A at a pulse width of 3 μs without beam blow up. For short pulse beam acceleration, a 1.6 A beam at a pulse width of 10 ns is obtainable at 7 MeV. (auth) (NSA of Japan)

22500 OPERATING CHARACTERISTICS STUDY OF THE HIGH FREQUENCY COCKCROFT-WALTON TYPE HIGH POWER ELECTRON ACCELERATOR HYPERTRON. Arakawa, Kazuo; Inoue, Takashi (Matsushita Electrical Industry Co., Ltd., Japan). Nat. Tech. Rep. (Matsushita Elec. Ind. Co., Osaka), 13: 399-409 (Dec. 1967). (In Japanese).

A 1.5-MeV output current accelerator has been developed and its long-term reliability confirmed. Tests revealed voltage and current fluctuation below 2%/100 hrs and 3%/100 hrs, respectively. The life of the electron gun, a most important factor in an industrial accelerator, was 4000 hrs. The shut-down rate due to maintenance and trouble was approximately 10%. Also described are some of the operating characteristics, construction and operating principles. (auth) (NSA of Japan)

22501 MPL-5 PROTON LINEAR ACCELERATOR. Fujita, Hyota; Nagai, Akio (Mitsubishi Electric Corp., Japan). Mitsubishi Denki Lab. Rep., 42: 362-8(Feb. 1968). (In Japanese).

The device is capable of accelerating a proton beam, pre-accelerated with a 500-keV Cockcroft-type accelerator, as high as 5 MeV. The accelerating cavity is 1 m in diameter and 3.7 m long, being made of copper clad steel board and provided with 37 drift tubes. The high frequency generated is 202.56 MHz, in the resonance of TM_{010} mode; the R. F. peak power is 350 kW. A proton beam current of 10.3 mA max (peak value) is available, but construction work is going on to increase the high frequency power above 1 MW, so that current above 50 mA may be obtained in the near future. (auth) (NSA of Japan)

22502 ACCELERATING STRUCTURE OF ML-300 ELECTRON LINAC FOR TOHOKU UNIVERSITY. Ikeda, Shigeyuki; Otsubo, Youichirou (Mitsubishi Heavy Industry, Ltd., Japan). Mitsubishi Denki Lab. Rep., 42: 287-92(Feb. 1968). (In Japanese).

In constructing the linac for Tohoku University, Mitsubishi Heavy Industries have built and installed accelerating structures, couplers, and stands for the accelerating structures and cooling systems of the structure; all are successful in attaining anticipated results. To the accelerating structure was demanded a very rigid phase accuracy of within ±5°. As a result of painstaking effort, a method of manufacturing the device has been developed by a copper spacer system which meets the above accuracy. Other technological requirements have been met with success. Employment of helical fin coolers and demountable couplers to make the installations compact stand out among many features. (auth) (NSA of Japan)

22503 COOLING DEVICE OF ACCELERATING STRUCTURE OF ML-300 ELECTRON LINAC FOR TOHOKU UNIVERSITY. Ikeda, Shigeyuki; Machiyama, Yoshihiko (Mitsubishi Heavy Industry Ltd., Japan). Mitsubishi Denki Lab. Rep., 42: 293-6(Feb. 1968). (In Japanese).

A linear accelerator for Tohoku University has been built with very severe performance which owes a great deal to the structural and dimensional accuracy of accelerating structure. Temperature control accuracy during operation is also very important. Thus design of the cooling system is critical. A performance requirement of the cooling system and heat transfer characteristics when special cooling jackets are in use are described. Axial temperature distributions obtained from calculation and experiment are discussed. Also, cascade control for the solution of the temperature control characteristics in designing the cooling system is examined. (auth) (NSA of Japan)

22504 MEASURING AND CONTROLLING SYSTEMS OF ML-300 ELECTRON LINAC FOR TOHOKU UNIVERSITY. Irie, Koichi; Suzuki, Toshimitsu (Mitsubishi Electric Corp., Japan). Mitsubishi Denki Lab. Rep., 42: 312-19(Feb. 1968). (In Japanese).

At the standpoint of the accelerator operation, this description has been made on the control performance called for by individual apparatus composing the accelerator. Concerning the main parts of the accelerator, the text covers evacuation, cooling, microwave power supply, waveguide circuits, electron gun, beam focusing, and steering systems. In the acceleration of beams are possible the

control of electron gun, adjustment of bunching with microwave phases, and the control of other accelerating systems. With regard to beam transport systems, measuring and controlling systems are composed so as to permit the change-over for various experimental objectives in two experimental areas. A monitoring system has been put in order to watch the radiation levels in the environment and buildings. Control systems for evacuation, cooling, microwave power supply, waveguide circuits, electron gun, beam focusing, and steering systems are described. Controls for beam switching systems for beam change-over to two experimental areas are discussed. Also, an environmental monitoring system is examined. (TSS) (NSA of Japan)

22505 BEAM TRANSPORTS OF ML-300 ELECTRON LINAC FOR TOHOKU UNIVERSITY. Gotoh, Masayuki; Akiba, Toshimitsu (Mitsubishi Electric Corp., Japan). Mitsubishi Denki Lab. Rep., 42: 320-7(Feb. 1968). (In Japanese).

As a result of study based on beam dynamics, a buncher system easy to build and having good performance has been completed. Due to beam blow-up, an acceleration tube of one unit, a process to suppress HEM_{11} mode oscillation has been discovered. The beam break-up of the new type occurs in a horizontal plane crossing with the direction of the RF-coupler. Trial of restraining BBU by inserting quadruple magnets has resulted in the procurement of accelerating currents of 350 mA, 3 μs at A section, and of 100 mA, 3 μs at A + B sections. Design and manufacture of three transport systems have been executed by the use of beam optics with the numerical calculation. Achromatic electron beams are transported to two experimental areas. The maximum resolution of 0.10% at system II has been measured and confirmed with an electron spectrometer. (auth) (NSA of Japan)

22506 RESEARCH APPARATUS OF ML-300 ELECTRON LINAC FOR TOHOKU UNIVERSITY. Gotoh, Masayuki; Miyashita, Kyoichi (Mitsubishi Electric Corp., Japan). Mitsubishi Denki Lab. Rep., 42: 328-33(Feb. 1968). (In Japanese).

An irradiation magnet for biological experiments, a broad-range spectrometer, and a huge electron spectrometer which have been installed in experimental areas to start practical operation are described. Mechanisms of a large scale, magnets of high resolution or of broad-ranges, and further arrangement of semiconductor detector and data treatment devices have been completed by overcoming many new technological difficulties. The characteristics of magnets, detecting and measuring sections, and construction and function of the interface section with computers are discussed. (auth) (NSA of Japan)

22507 COOLING SYSTEM OF ML-300 ELECTRON LINAC DELIVERED FOR TOHOKU UNIVERSITY. Ikeda, Kazuo; Kanazawa, Masahiro (Mitsubishi Electric Corp., Japan). Mitsubishi Denki Lab. Rep., 42: 334-40(Feb. 1968). (In Japanese).

The cooling system for the electron linac at Tohoku University is described. Considerations for radiation effects, maintaining water purity above 5×10^4 ohm-cm, and regulating water temperature at 40°C ± 0.2°C are discussed. The operation and performance of the system is presented. (TSS) (NSA of Japan)

22508 HIGH-POWER PULSERS OF ML-300 ELECTRON LINAC FOR TOHOKU UNIVERSITY. Abe, Hisayasu; Ikeda, Kazuo (Mitsubishi Electric Corp., Japan). Mitsubishi Denki Lab. Rep., 42: 306-11(Feb. 1968). (In Japanese).

A brief report on the construction and performance of various kinds of pulse modulators built for the 300-MeV electron linear accelerator at Tohoku University is presented. Klystron pulsers, used with the world largest klystrons TV-2014, are designed to be capable of continuous operation on the maximum duty. The dc power supply output is 112 kW at 26 kV, supplying 250 kV and 270 A pulses to the klystron with a pulser having an output of 100 kV at the maximum and a gun grid pulser with a pulse width of 0.01 ~ 3.8 μs for the control and modulation of emission current are used. These apparatus are all provided with semiconductors except for a switching thyratron. (auth) (NSA of Japan)

22509 VACUUM SYSTEM OF ML-300 ELECTRON LINAC FOR TOHOKU UNIVERSITY. Fujinaga, Atsushi; Tottori, Hiroshi (Mitsubishi Electric Corp., Japan). Mitsubishi Denki Lab. Rep., 42: 341-6(Feb. 1968). (In Japanese).

One of the important problems with the ML-300 electron linac is producing a good vacuum without contamination by organic vapor. Another one is determining the economically optimum number of pumps to maintain a high vacuum. The whole system of the linac is provided with metal gaskets. Ion pumps are used for evacuation and very successful results are obtained. The outgassing rate of each component part is made below 2×10^{-11} torr l/sec-cm^2 through heat treatment. The pressure during acceleration is down to 1×10^{-6} torr, which enables the system to work steadily. (auth) (NSA of Japan)

22510 POLARIZED ^{3}He-ION BEAM. Baker, S. D.; Carter, E. B.; Findley, D. O.; Hatfield, L. L.; Phillips, G. C.; Stockwell, N. D.; Walters, G. K. (Rice Univ., Houston, Tex.). Phys. Rev. Lett., 20: 738-40(Apr. 1, 1968).

The use of an optical pumping technique for the production of a positive-ion beam of polarized ^{3}He is reported. The intensity, ion-optical quality, and polarization of the beam make it suitable for injection into appropriate accelerators for use in nuclear scattering studies and nuclear structure research. A nuclear polarization of 0.05 in the beam was directly measured by means of a nuclear double-scattering experiment, during which the beam intensity was 3 to 4 mA and the emittance approximately 1 cm rad eV^{½}. (B.G.D.)

22511 ACTIVATION OF ARGON NEAR A TARGET IRRADIATED BY 3 GeV PROTONS. Awschalom, M.; Larsen, F. L.; Schimmerling, W. (Princeton Univ., N. J.). Health Phys., 14: 345-51(Apr. 1968).

The production of ^{41}Ar, ^{34m}Cl, ^{24}Na, and ^{35}S from ^{40}Ar was measured in the vicinity of a target bombarded by 3 GeV protons Qualitative evidence was also found for the presence of other radioactive nuclides. Concentrations of 10^{-4} to 10^{-7} μCi/cc at 1 m were found for a beam current of 1.5×10^{10} p/sec on a 1¼ in. Pb target. (auth)

22512 SIX MeV MEDICAL LINEAR ACCELERATOR MADE IN JAPAN. Kitabatake, Takashi; Takahashi, Shinji (Nagoya Univ., Japan). Nippon Igaku Hoshasen Gakkai Zasshi, 27: 1283-95(Jan. 1968). (In Japanese).

A 6 Mev medical linear accelerator manufactured by the Mitsubishi Heavy Industries, LTD., was installed in the Aichi Cancer Center. This machine is the first one of this type of units made in Japan. The construction, results of tests for radiation and mechanical accuracy, and circumstance of trouble and maintainance are discussed. One of the most striking characteristics of this machine is a mechanism that deflects the electron beam, coming out of the accelerator tube, 180 degrees, using two steps of deflection magnet system. The maximum x ray output was 465 R/min at one meter with the actual maximum energy of 5.75 MeV. The unit was acting for clinical radiotherapy for last 6 months, however treatment was interrupted only one day because of machine trouble. Details written in English will be published by the same authors in the forth-coming paper of Tohoku J. exp. Med. (auth) (NSA of Japan)

22513 PULSED OPERATION OF AN ANALYZER OF THE HIGH-FREQUENCY STRUCTURE OF A BEAM OF HIGH-ENERGY NUCLEAR PARTICLES. Vysocansky, Milan; Ondris, Lubomir; Lehotay, Eugen; Nagy, Ladislav (Electrical Engineering Inst., Bratislava). Elektrotech. Cas., 18: 187-206(Mar. 1967). (In Czech).

Various problems connected with the application of the time-analysis method by means of controlled photomultiplies on the accelerator, working under conditions of so-called multiple acceleration, are discussed. (JPRS)

22514 EQUIPMENT FOR MEASURING THE hf STRUCTURE OF HIGH-ENERGY NUCLEAR PARTICLES BEAM. Vysocansky, M.; Ondris, L.; Nagy, L.; Lehotay, E. (Electrical Engineering Inst., Bratislava). Elektrotech. Cas., 18: 117-37(1967). (In Czech).

A description is given of a new type of time analyzer which operates on the principle of fast coincidence registration by controlled photomultipliers. This principle is particularly advantageous for the analysis of nuclear particles for which the occurrence probability is limited to a certain region of high-frequency voltage phases. Such limitations occur, for example, at the output of accelerators of the synchrocyclotron (measurement of beam microstructure) type; or in beams leading to dynamic separators, with no difference if the primary beam is modulated in the synchrophasotron chamber (as at Dubna) or if modulation occurs only in the channel of pure particles (as at CERN). The given method can be used for the time analysis of all periodically repeating physical phenomena accompanied by bursts of light. If one is satisfied with a smaller recording efficiency, one can, by measuring the level of the so-called random coincidences, enlarge the applicability of this method to cover the measurement of phenomena whose description of occurrence is purely statistical. The analyzer described in the paper originated from a direct need for physical measurements of a high-energy nuclear particle beam. The beam of particles entering the dynamic separator must be density modulated. The occurrence of particles at an arbitrary point in the channel is rigidly linked with a determined phase of the modulation voltage with a frequency of 150 MHz. With the given separation method, the requirements for the hf structure of the beam are very rigorous, because the degree of

"contamination" of the beam depends on the structural parameters and, consequently, on the parameters of the measuring equipment. During two years of experiments with the accelerator beam, the equipment gave satisfactory results, and it has been decided to establish it permanently at the antiproton channel of the 5-GeV synchrophasotron in Dubna, where it will be used for physical measurement of the beam and also for further methodological investigations of controlled photomultipliers. (ATD)

22515 PRODUCTION OF NEGATIVE IONS IN A HIGH-FREQUENCY ION SOURCE. Reuther, E.; Bethge, K. (Univ., Heidelberg). Z. Angew. Phys., 24: 227-31(1968). (In German).

The production of negative ions in a high-frequency ion source is described. The negative ion current was measured as a function of geometrical and electrical parameters and was found to be limited by the conditions under which the maximum positive ion current is extracted out of the plasma and focused through the extraction channel of the source. The maximum currents obtained were: H^- : 2 μA; Li^- : 80 nA; C^- : 200 nA; O^- : 3 μA. (auth)

22516 MEGAGAUSS CNARE TARGETS FOR HIGH ENERGY MAGNETIC BREMSSTRAHLUNG. Erber, T. (Illinois Inst. of Tech., Chicago). Z. Angew. Phys., 24: 188-91(1968).

Experimental problems associated with the detection and measurement of magnetic bremsstrahlung in megagauss fields are considered. The practical realization of the experiment depends of the synchronization of a Cnare implosion with a high energy linac pulse. (auth)

22517 CYCLOTRON ACCELERATOR HAVING THE ELECTROSTATIC FIELD APPEARING ACROSS A NONLINEAR GAP. Thomas, Llewellyn H. (to International Business Machines Corp.). U. S. Patent 3,348,089. Oct. 17, 1967. Filed July 29, 1963.

A cyclotron is described which employs a constant magnetic field and an alternating electric field whose equipotential contours may assume any configuration, preferably circular. The field occurs across a generally circular gap between a pair of circular plates and a pair of annular plates that surround the circular plates such that the gap appears at the circumference of the circular plates. A very high-intensity output beam is produced. (W.H.K.)

22518 APPARATUS FOR DAMPING AXIAL COHERENT BEAM INSTABILITIES IN A SYNCHROTRON PARTICLE ACCELERATOR. Hilden, Richard H.; Martin, John H.; Mills, Frederick E.; Winje, Russell A. (to United States Atomic Energy Commission). U. S. Patent 3,378,778. Apr. 16, 1968.

This patent describes a control system for damping axial coherent oscillations in bunches of charged particles traveling in a fixed orbit in a synchrotron particle accelerator. The control system accomplishes its function by detecting the amplitude of the oscillation of a bunch when the bunch passes a first location along the orbit, tracking the bunch in its orbit, and applying a damping force, proportional to the magnitude of the detected oscillation, at the exact time when the bunch passes a second location along the orbit. The tracking and timing are accomplished by means of a discretely variable delay line controlled by the instantaneous frequency of the energy source driving the accelerator. (AEC)

PHYSICS (NUCLEAR)

Neutron Interactions with Matter

Refer also to abstracts 22263, 22264, 22267, and 22607.

22519 (BNL–12322) IMPORTANCE OF THE CORRECT TREATMENT OF THE SCATTERING INTEGRAL IN THE BOLTZMANN EQUATION IN DEEP PENETRATION CALCULATIONS IN IRON. Wagschal, J. J.; Levine, M. M.; Chernick, J. (Brookhaven National Lab., Upton, N. Y.). [1967]. 24p. (CONF-680412-1). Dep. CFSTI.

From Special Annual Meeting of the Israel Physical Society, Jerusalem, Israel.

In the calculation of the deep penetration of neutrons in iron slabs the question of how many terms should be kept in the Legendre polynomial expansion of the scattering integral in the Boltzmann equation comes up. Experience in reactor calculations showed that there is practically no difference in either critical mass or neutron spectrum between calculations or order $L \geq 2$ in the scattering integral. Even the transport approximation and the $L = 1$ approximation have been within 0.5% of the higher approximations. The propagation of neutrons through many mean free paths of an anisotropically scattering medium is found to be much more sensitive to the number of terms in the expansion. S16 calculations have been performed for the penetration of neutrons from a plane source through thick slabs of iron using different L approximations. Similar calculations have been done for fictitious materials with a delta function scattering law in different directions in the forward hemisphere. The comparison of the scalar flux calculated by various L approximations shows deviations of less than 0.1% for $L \geq 4$ in most cases. On the other hand the scalar flux of an $L = 2$ calculation deviates by more than 5% from the higher-order approximations. (auth)

22520 (CEA-R-3317) CONTRIBUTION A L'ETUDE EXPERIMENTALE DE LA DIFFUSION CRITIQUE DES NEUTRONS FROIDS PAR LE FER. (Contribution to the Experimental Study of the Critical Scattering of Cold Neutrons in Iron). Konstantinovic, Jovan (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires). 1967. 71p. (In French). Dep.

Thesis. Submitted to Faculte des Sciences, Univ. of Paris, France.

The scattering of neutrons by iron near the Curie temperature was investigated. The analysis of the experimental data confirms the $(T - T_c)^{\frac{1}{2}}$ dependence of the magnetic susceptibility near the Curie point, which was predicted on the basis of the Heisenberg model. However, the analysis reveals a non-zero relaxation time for the magnetic fluctuations at the Curie point, which is in disagreement with theoretical predictions. (D.C.W.)

22521 (DP–1090) THERMAL NEUTRON DIFFUSION IN LIGHT AND HEAVY WATER. Parks, P. B.; Pellarin, D. J.; Prochnow, N. H.; Baumann, N. P. (Du Pont de Nemours (E. I.) and Co., S. C. Savannah River Lab.). Feb. 1968. Contract AT(07-2)-1. 40p. Dep. CFSTI.

The thermal neutron diffusion coefficients for H_2O and D_2O were determined from static measurements of the neutron relaxation length in boron-poisoned H_2O and D_2O and pulsed measurements of the neutron die-away in different-sized containers of these two moderators. The H_2O results agree well with previous measurements and fairly well with theory. The diffusion coefficients determined for H_2O are: $D_0 = 3.57 \pm 0.04 \times 10^4$ cm^2 sec^{-1}, $C = 3.31 \pm 0.15 \times 10^3$ cm^4 sec^{-1}, and $F = 2.8 \pm 0.7 \times 10^2$ cm^6 sec^{-1}. The D_2O results agree reasonably well with calculations in the range of poison concentrations $\Sigma_a(B) = -0.04$ to $+0.04$ cm^{-1}. The restricted diffusion coefficients determined for D_2O are: $D_0 = 2.09 \pm 0.02 \times 10^5$ cm^2 sec^{-1} and $C = 6.6 \pm 0.03 \times 10^5$ cm^4 sec^{-1}. The pulsed measurements for D_2O resolved a previous discrepancy between pulsed and static determinations of D_0. The static measurements included neutron spectral index determinations as a function of neutron source and poisoning conditions. The theoretically predicted strong dependence of spectral indices on neutron source conditions in D_2O was verified. Evidence was also found for the existence of a pseudo energy equilibrium distribution in heavily poisoned D_2O. Normal analysis of this unusual data led to an assignment of the inverse diffusion length, κ, which exceeded Corngold's limit at $\kappa = \Sigma_s$, the free atom scattering cross section. (auth)

22522 (GA–8283) DIFFERENTIAL NEUTRON THERMALIZATION. Final Report. Whittemore, W. L. (Gulf General Atomic, Inc., San Diego, Calif.). Nov. 1, 1967. Contract AT(04-3)-167. 112p. Dep. CFSTI.

A neutron velocity selector was used to study the details of neutron scattering in reactor-grade graphite, in liquid D_2O, and in BeO. The scattering into various angular directions between 30 and 150° was studied for incident neutrons with energies ranging up to ~0.7 eV. The energy-transfer cross sections, corrected for plural scattering effects, are evaluated to provide data in regions of large energy and momentum transfers not previously available and not readily accessible to experimenters using a reactor as a source of neutrons. The results for D_2O and graphite are quite definitive and, when compared to the best available theories, indicate some regions of good agreement and some regions where better theoretical treatment may be needed. The results for BeO are preliminary but agree reasonably well with previous experimental results. (auth)

22523 (NAA-SR-12533) LEGENDRE EXPANSION COEFFICIENTS FOR THEORETICAL ANGULAR DISTRIBUTIONS OF ELASTICALLY SCATTERED NEUTRONS. Campbell, R.; Alter, H.; Berland, R.; Luco, V. (Atomics International, Canoga Park, Calif.). Mar. 1, 1968. Contract AT(04-3)-701. 34p. Dep. CFSTI.

Theoretically calculated angular distributions for elastically scattered neutrons were analyzed in terms of Legendre polynomial expansions. The theoretical calculations were performed by Agee and Rosen (LA-3538-MS, Vols. I and II) and were based on combined optical model and Hauser-Feshback theory. From their results, thirty-six isotopes, ranging in mass from sodium to plutonium-240, were analyzed. The resulting Legendre expansion coefficients have been forwarded to Brookhaven National Laboratroy (BNL) in an ENDF/A compatible format, and are available from the National Neutron Data Center (NNDC) at BNL on request. (auth)

22524 (ORNL-RSIC-19) REVIEW OF THE DISCRETE ORDINATES S_n METHOD FOR RADIATION TRANSPORT CALCULATIONS. Trubey, D. K.; Maskewitz, Betty F. (eds.) (Oak Ridge National Lab., Tenn.). Mar. 1968. Contract W-7405-eng-26. 224p. Dep. CFSTI.

Résumés are presented of papers given at a seminar-workshop on "The Discrete Ordinates S_n Method for Radiation Transport Calculations" held at Oak Ridge, Tennessee, August 14 to 16, 1967. The papers, in their review of the state-of-the-art, establish the fact that this method of solving the Boltzmann transport equation is now often the method of choice for one-dimensional and sometimes two-dimensional deep penetration calculations. A large number of computer codes which solve one-dimensional problems were reported. These include DTF-IV, DDK, GAPLSN, GGSN, 1DF, ODD-K, DTA, and ANISN. In addition there were some two-dimensional codes reported including 2DF, TDSN, and DOT. The recently developed ANISN computer code, described in detail in the workshop, has been placed with the Radiation Shielding Information Center for routine dissemination. (auth)

22525 (RPI–328-112) LINEAR ACCELERATOR PROJECT. Progress Report, October 1, 1967–December 31, 1967. (Rensselaer Polytechnic Inst., Troy, N. Y.). Contract AT(30-3)-328. 119p. Dep. CFSTI.

Separate abstracts were prepared for four of the five sections of the report. The other section comprises a preliminary report, in summary form, of measurements of time-dependent spectra in the center of a $10 \times 10 \times 3$ in.^{3} light water slab. (D.C.W.)

For abstracts of individual sections see: 22526–22528 and 22592.

22526 (RPI–328-112, pp 16-59) FAST REACTOR PHYSICS: EXPERIMENTAL. (Rensselaer Polytechnic Inst., Troy, N. Y.).

An analysis of time-of-flight measurements of position-dependent fast neutron spectra in iron was made, and position- and angle-dependent fast neutron spectra in a depleted uranium assembly were measured. The first and second time moments of flux distributions as functions of energy and position in experimental fast assemblies were calculated. The efficiency of sodium iodide detectors with B_4C radiators for fast neutron detection was investigated. (D.C.W.)

22527 (RPI–328-112, pp 62-103) REACTOR PHYSICS: THEORETICAL. (Rensselaer Polytechnic Inst., Troy, N. Y.).

The temperature dependence of the ^{56}Fe resonances between 20 and 60 keV was calculated using the FASDOP code, and a study of the slowing down of fast neutrons in heavy materials was begun. Re-entrant hole perturbation calculations were performed, and static tilt test problems were analyzed using the discontinuous

trial function approach. An analytic flux representation was formulated for fast reactors. (D.C.W.)

22528 (RPI-328-112, pp 104-19) LOW-ENERGY NEUTRON INELASTIC SCATTERING (LENIS). (Rensselaer Polytechnic Inst., Troy, N. Y.).

The influence of optical mode parameters in effective temperature calculations for Doppler broadening in UC was investigated, and a Monte Carlo code for multiple scattering corrections was completed. Neutron doubly differential scattering cross sections for H_2O at 200°C and for stretch-oriented polyethylene were measured. (D.C.W.)

22529 (UJV-1932) VYPOCET DOPPLEROVYCH FUNKCI $\psi(\theta,x)$; $\chi(\theta,x)$; $J(\theta,\beta)$ A $J(\theta,\beta,i)$. (Calculation of Doppler Functions $\psi(\theta,x)$; $\chi(\theta,x)$; $J(\theta,\beta)$ and $J(\theta,\beta,i)$). Stepanek, J. (Ceskoslovenska Akademie Ved, Rez. Ustav Jaderneho Vyzkumu). Dec. 1967. 72p. (In Czech). Dep.

The simplest method for the calculation of Doppler function is described from the point of view of time calculation. In the first part Doppler functions $\psi(\theta,x)$ and $\chi(\theta,x)$ are described, which were introduced by Voigt. With the help of these functions the energy dependence of the absorption as well as the scattering of neutrons in an isolated resonance of the absorber is described. Calculation of these functions is divided into two regions for $x \geq A/\theta$ and $x < A/\theta$, where for practicable accuracy 10^{-4} is A = 7.3. In the $x \geq A/\theta$ region for calculation of the function $\psi(\theta,x)$ and $\chi(\theta,x)$, an asymptotic relation is used in the form of the infinitive sum; in the second region for $x < A/\theta$, an analytic method was chosen which had been described by Dandieu, Gautier, Guillermin, Olivier, and Roche. In this work functions $\psi(\theta,x)$ and $\chi(\theta,x)$ are calculated using a sum in which the first members depend on $\psi(\theta,0)$. This method is compared with the Reichels' method which uses Hermite polynomials and with that of Buckler and Pull. Tables of the $\psi(\theta,x)$ and $\chi(\theta,x)$ functions are also produced for θ = 0.001, 0.005, 0.01, 0.05, 0.1, 0.5, and 1 and x = 0 to 900. In the second part, Doppler functions $J(\theta,\beta,i)$ and $J(\theta,\beta)$ are described. For their calculation the Wijngaardens' method is taken. An effect of interference scattering in dependence on i, β, and θ was compared. The $J(\theta,\beta)$ function was also approximated with a maximum relative error $<6.10^{-4}$. (auth)

22530 (WAPD-TM-761) DAFT1: A FORTRAN PROGRAM FOR LEAST SQUARES FITTING OF 0.0253 eV NEUTRON DATA FOR FISSILE NUCLIDES. Harris, D. R. (Bettis Atomic Power Lab., Pittsburgh, Pa.). Feb. 1968. Contract AT(11-1)-Gen-14. 21p. Dep. CFSTI.

A FORTRAN IV program DAFT1 for weighted least squares fitting of 0.0253-eV neutron data for fissile nuclides is described. The program also carries out computations relevant to discerning overall goodness of fit, particularly deviant data, and data whose improvement would lead to large reductions in error of each fitted parameter. (auth)

22531 TIME-OF-FLIGHT EFFECTS IN PULSED-NEUTRON MEASUREMENTS. Price, Glenn A.; Windsor, Henry H. (Brookhaven National Lab., Upton, N. Y.). Nucl. Sci. Eng., 31: 547-9 (Mar. 1968). (BNL-11772).

Calculations are summarized which show a strong dependence of the neutron decay constant on the spectrum in a moderating assembly when the detector and assembly are separated by small distances. These calculations confirm experimental evidence that measurements of decay constants are quite sensitive to the location of the external neutron detector. It is concluded that all measurements of neutron decay rates that use an external detector may be subject to rather large errors due to time-of-flight effects. (S.F.L.)

22532 COMMENTS ON "ON NEUTRON WAVE PROPAGATION EXPERIMENTS IN GRAPHITE BY M. UTSURO AND T. SHIBATA." Ahmed, Feroz; Grover, P. S. (Univ. of Delhi). J. Nucl. Sci. Technol. (Tokyo), 5: 132(Mar. 1968).

An attempt was previously made (J. Nucl. Sci. Technol. 4: 205 (1967)) to interpret experimental results on the effect of the Bragg cut-off on neutron wave propagation in graphite by a two-group theory, taking one group above and the other group below the Bragg cut-off energy for graphite. Coupling between the two energy groups was neglected, and a comparison of theoretical predictions with experimental data indicated that the neglect of coupling was justified. It is shown that the coupling between the two groups is important and that the neglect of coupling leads to results which are even qualitatively different. (D.C.W.)

22533 SOME INVESTIGATIONS OF THE EFFECT OF "BRAGG CONTINUUM" ON WAVE PROPAGATION EXPERIMENTS IN GRAPHITE. Takahashi, Akito; Sumita, Kenji (Osaka Univ.). J. Nucl. Sci. Technol. (Tokyo), 5: 137-6(Mar. 1968).

An analysis of the effect of the Bragg continuum on neutron wave propagation in systems with transverse dimensions of up to 130 cm is summarized, together with some experimental observations on such systems. (D.C.W.)

22534 THE PURPOSE, INTERPRETATION, AND UTILIZATION OF AREA MONITORING MEASUREMENTS NEAR THE CERN ACCELERATORS. Goebel, K.; Rindi, A.; Sullivan, A. H.; Baarli, J. (CERN, Geneva). pp 435-58 of Radiation Dose Measurements. Their Purpose, Interpretation, and Required Accuracy in Radiological Protection. Paris, European Nuclear Energy Agency, 1967.

From Symposium on Radiation Dose Measurements, Their Purpose, Interpretation, and Required Accuracy in Radiological Protection, Stockholm. See CONF-670621.

The measurement of the radiation hazard from the stray radiation around high energy particle accelerators is complicated by the complex radiation mixtures that are found. No suitable instrument exists for measuring directly the dose equivalent and indirect methods have to be employed. These methods pose problems of interpretation which result in different interpretations at different high energy research centers of instruments with the same response. As yet there is little agreement as to the methods to be used to estimate the dose equivalent within the meaning laid down by the ICRP and existing recommendations can be ambiguous. After a short discussion of the general purpose of area monitoring around the CERN accelerators the results of measurements are analyzed in an attempt to assess the methods adopted at CERN for estimating the dose equivalent. Discussions are also devoted to the way in which these results are utilized in practice for radiation protection purposes.

22535 AN IMPROVED METHOD FOR CALCULATING RETHERMALIZATION NEUTRON CROSS SECTIONS. Carlson, Roger W.; Hansen, K. F. (Massachusetts Inst. of Tech., Cambridge). Nucl. Sci. Eng., 31: 369-76(1968).

The application of the free-gas scattering kernel to the problem of calculating rethermalization cross sections is extended by the inclusion of velocity dependence in the cross section within the free-gas scattering kernel. The cross section within the scattering kernel is a function of the relative velocity between neutrons and moderator and is hereafter referred to as the relative cross section. The scattering cross section which is calculated from the free-gas scattering kernel is shown to obey a differential equation of the same form as the one-dimensional heat-flow equation with the relative cross section occupying the position of the initial condition. The relative cross section is numerically determined and its use is shown to give improved agreement with Parks' kernel for both the elements and the moments of the scattering kernel. The moments of the improved free-gas kernel are used to calculate thermal-flux spectra as well as rethermalization cross sections which are both in better agreement with experimental values than is obtainable with the free-gas kernel. The rethermalization cross sections, which are based upon the improved free-gas kernel, are used to predict power profiles at temperature and absorption discontinuities and the results are in better agreement with experimental values than was obtainable using the free-gas scattering kernel. (auth)

22536 ANALYSIS OF POLARIZED NEUTRON SPECTRUM WITH THE AID OF CONSTANT MAGNETIC FIELDS. Drabkin, G. M.; Trunov, V. A.; Runov, V. V. (Ioffe Inst. of Physics and Tech., Leningrad). Z. Eksp. Teor. Fiz., 54: 362-6(Feb. 1968). (In Russian).

A new principle of analysis of the polarized neutron spectrum was checked experimentally. The principle essentially reduces to the creation of resonance conditions for the spin-flip of neutrons by time-constant magnetic fields of definite configurations. A three-axis spectrometer of polarized neutrons was used. The principal resonator parameters are determined; they are in agreement with the calculated values. It is shown that the line half-width can be essentially decreased without any intensity loss with the aid of the proposed selector. (auth)

22537 PARAMAGNETIC SCATTERING OF NEUTRONS BY RARE-EARTH IONS: CALCULATED PARAMAGNETIC CROSS SECTIONS FOR Ce, Pr, Nd, Gd, Tb, Dy, Ho, Er, Tm, AND Yb. Mattos, Marieta C. (Instituto de Energia Atomica, Sao Paulo, Brazil). J. Chem. Phys., 48: 520-2(Jan. 1, 1968).

Neutron paramagnetic scattering cross sections for rare-earth ions were calculated using Trammell's theory (Phys. Rev., 92: 1387 (1953)). The formula $\sigma_{pm} = \frac{2}{3}\pi(e^2/mc^2)^2\gamma^2\mu^2\overline{f^2}$, where e^2/mc^2 is the classical electronic radius; γ and μ are the magnetic moments of the neutron and the atom, respectively; and $\overline{f^2}$ is the average over all scattering angles of the square of the magnetic form factor, was used. Values of $\overline{f^2}$ were calculated as a function

of wavelength by numerical integration, and the total paramagnetic cross sections of the rare earths were calculated as a function of energy between 0.001 and 0.12 eV. (D.C.W.)

22538 PULSED NEUTRON SOURCE FOR THERMAL REACTOR PHYSICS. Sumita, Kenji (Japan Atomic Energy Research Inst., Osaka); Kaneko, Yoshihiko; Kurokawa, Ryosuke; Adachi, Takeshi; Ogawa, Kazuyuki; Miyoshi, Katsuhiko. J. Nucl. Sci. Technol. (Tokyo), 4: 328-38(July 1967).

A compact 200-kV Cockcroft-type pulsed neutron source was designed and constructed as a versatile tool for various pulsed neutron experiments in thermal reactor physics. Special care was taken to obtain the maximum peak intensity of pulsed neutrons against the average background neutrons induced from accelerator operation. To this end, two particular design features were adopted. One is pulsing of the rf ion source probe voltage combined with pulsing of the deflector voltage of the post accelerated D^+ ion beam. The other feature is the use of a beam analyzing magnet on the accelerated beam. With these devices, a peak to background ratio of 10^6 was obtained. Pulsed neutrons of 14 MeV can be generated at pulse widths from 0.13 μsec to 500 msec, with a neutron yield of $3.7 \times 10^4 \sim 2 \times 10^9$ n/pulse. The repetition rate of the pulses can be changed independently of the pulse width. An arrangement for long focusing beam adjustment provides for selection of the target position in a wide range. (auth)

22539 NEUTRON ELASTIC DIFFUSE SCATTERING FROM MIXED MAGNETIC SYSTEMS. Marshall, W. (Atomic Energy Research Establishment, Harwell, Eng.). J. Phys., C, 1: 88-101 (Feb. 1968).

In a mixed magnetic system, such as a ferromagnetic alloy, there is a spatial inhomogeneity in the distribution of magnetization and this gives rise to a diffuse scattering of neutrons which is strictly elastic. The examination of this diffuse scattering is capable of giving information about the magnetization distribution on an atomic scale. In practice it is necessary to assume suitable models for the way in which each atom affects the magnetization in its immediate environment. Various models are described, and it is shown that, even for concentrated alloys where a number of effects must be allowed for, the cross-section formulas are simple. It follows that neutron experiments on mixed magnetic systems can be interpreted in terms of functions of physical significance. (auth) (UK)

22540 THE THERMAL-NEUTRON MILNE PROBLEM WITH CAPTURE. Lancefield, M. J.; Schofield, P. (Atomic Energy Research Establishment, Harwell, Eng.). J. Phys., D, 1: 137-47 (Feb. 1968).

A variational principle devised for the Milne problem without capture was extended to include capture. The theory is at present restricted to isotropic scattering. The flux in the energy-dependent problem is expressed in terms of the corresponding one-velocity solution having the same asymptotic spatial dependence and the one-velocity half-space Green function for an isotropic plane source. A variational principle for a quantity related to the extrapolation length may then be written down, and the emergent angular distribution determined by iterating the trial function. Results are presented for some simple scattering models. (auth) (UK)

22541 IMPROVEMENTS IN OR RELATING TO NEUTRON GENERATORS. Bounden, John Ellery (to United Kingdom Atomic Energy Authority). British Patent 1,103,152. Feb. 14, 1968. Filed Feb. 23, 1966.

An improved neutron generator is described which consists of a sealed-off envelope in which deuterium and/or tritium ions from an ion source are accelerated to strike a target containing deuterium and/or tritium to produce neutrons by the D–D and/or D–T reactions. The design used reduces the tendency for an electrical breakdown to occur between the shield electrode and extractor electrode of the ion source. (S.F.L.)

Nuclear Properties and Reactions, A≤5

Refer also to abstracts 21051, 22272, 22325, and 22412.

22542 VELOCITY-DEPENDENT NUCLEON–NUCLEON POTENTIAL AND THE MAGNETIC MOMENTS OF NUCLEI ^{3}H AND ^{9}Be. Dzhibuti, R. I.; Krupennikova, N. B.; Mamasakhlisov, V. I. (Inst. of Physics, Tbilisi, USSR). Yadern. Fiz., 7: 49-52 (1968). (In Russian).

The effect of a velocity-dependent Green potential in the magnetic moments of nuclei ^{3}H and ^{9}Be is investigated. It is shown that the corresponding correction to the ^{3}H magnetic moment is not substantial as a result of the small admixture of the D state in this nucleus, as well as because of the small ratio of the range of velocity-dependent nuclear forces to the mean internucleon distance. In case of ^{9}Be, the correction to the magnetic moment is about 14% of the value of the difference between Schmidt's value and the experimental quantity. (auth)

22543 INVESTIGATION OF THE ROLE OF THREE-PARTICLE FORCES IN THE TRITIUM PROBLEM APPLYING A NONLOCAL FACTORIZABLE POTENTIAL. Vashakidze, I. Sh.; Chilashvili, G. A. (Tbilisi State Univ., USSR). Yadern. Fiz., 7: 41-8(1968). (In Russian).

The effect of three-particle forces in the tritium problem is investigated with a nonlocal factorizable potential. It is shown that the experimental value of the tritium binding energy may be obtained if the three-particle forces are repulsive. (auth)

22544 POLARIZATION TRANSFER IN THE D(p,n)2p REACTION. Dass, G. V. (Atomic Energy Research Establishment, Harwell, Eng.); Queen, N. M. J. Phys., A, 1: 259-68(Mar. 1968).

The impulse approximation is used to predict the depolarization parameter (transverse polarization transfer coefficient) in the d(p,n)2p reaction as a function of the energy of the neutrons emitted in the forward direction, for incident proton energies between 30 and 150 MeV. Multiple-scattering corrections are shown to be small at the high-energy end of the final neutron spectrum, where the formalism is most reliable. The depolarization parameter for these high-energy neutrons is found to be negative over the entire range of incident proton energies considered, and increases in magnitude as a function of this energy. The value of this parameter is particularly sensitive, however, to the nucleon–nucleon phase shifts assumed in the calculation, so that its experimental determination would make it possible to discriminate between alternative sets of nucleon–nucleon phase shifts which fit all the two-body scattering data. (auth) (UK)

22545 VACUUM POLARIZATION AND LOW-ENERGY SCATTERING. Kermode, M. W. (Univ. of Liverpool). J. Phys., A, 1: 236-50(Mar. 1968).

The effects of vacuum polarization on the S-wave scattering of protons by protons and alpha particles by alpha particles are investigated. The calculations are exact. The inclusion of vacuum polarization gives a slightly improved effective range fit to the p-p scattering data. The width of the ground state of beryllium is calculated from the α-α scattering data. The value of 6.14 ± 0.04 eV compares favorably with the experimental value of 6.8 ± 1.7 eV. (auth) (UK)

Nuclear Properties and Reactions, 6≤A≤19

Refer also to abstracts 21051, 22272, 22523, 22542, 22545, 22560, 22576, 22614, 22631, and 22637.

22546 (WAPD-TM-667) FISSION SPECTRUM AVERAGED CROSS SECTION MEASUREMENT FOR ^{9}Be(n,2n) REACTION (LWBR–LSBR DEVELOPMENT PROGRAM). Green, L. (Bettis Atomic Power Lab., Pittsburgh, Pa.). Jan. 1968. Contract AT(11-1)-Gen-14. 18p. Dep. CFSTI.

The ^{252}Cf spontaneous fission neutron spectrum averaged ^{9}Be (n,2n) cross section was measured to an accuracy of 4% using a manganese sulphate bath technique. The value obtained, 144 ± 6 mb, agrees with the prediction of 150 mb based on the latest available differential cross section measurements. In particular, in the region 2 to 4 MeV where uncertainties in the data are greatest, the cross section is adequately described. (auth)

22547 ABOUT THE MOMENTUM DISTRIBUTION OF NUCLEON PAIRS IN THE ^{6}Li AND ^{7}Li GROUND STATES, OBTAINED BY NUCLEAR ABSORPTION OF SLOW PIONS. Pellegrini, F. (Univ., Padua. Istituto Nazionale di Fisica Nucleare, Padua). Nuovo Cim., 54B: 335-8(Apr. 11, 1968).

It is shown that simple shell-model predictions are in agreement with experimental results on the K-dependence of the total momentum of nucleon pairs from the ^{6}Li(π^-,2n)^{4}He and ^{7}Li(π^-,2n)^{5}He reactions. (D.C.W.)

22548 AKHIESER–POMERANCHUK–BLAIR MODEL CALCULATIONS IN THE ELASTIC SCATTERING OF ALPHA PARTICLES FROM LIGHT NUCLEI. Rahman, M. (Atomic Energy Centre, Dacca, Pakistan); Khan, A. H.; Sen Gupta, H. M. Nuovo Cim., 54B: 260-6(Apr. 11, 1968). (AECD/TP-21).

Angular distributions of alpha particles elastically scattered from C, N, O and A were analyzed in terms of the semiclassical Akhieser-Pomeranchuk-Blair model, and the best-fit parameters

were obtained. Finally, the interaction radius and the surface diffuseness were calculated from the parameter values thus obtained. (auth)

22549 ANGULAR DISTRIBUTIONS IN THE GIANT RESONANCE OF ^{16}O. Stewart, R. J. J. (Univ. of Melbourne, Parksville, Australia). Aust. J. Phys., 21: 107-12(Apr. 1968).

The reaction $^{16}O(\gamma,p_0)^{15}N$ was studied in the region of excitation in ^{16}O from 20.5 to 25.6 MeV. Angular distributions on the resonances observed were extracted from the spectra, which were taken at 20° intervals from 30 to 150°. The results are compared with other related work. (auth)

22550 EFFECTIVE CROSS SECTIONS OF INELASTIC INTERACTIONS OF 10^{10} TO 10^{12} eV PROTONS WITH CARBON NUCLEI MEASURED WITN PROTON-1 AND PROTON-2 INSTRUMENTS. Grigorov, N. L.; Nesterov, V. E.; Rapoport, I. D.; Savenko, I. A.; Skuridin, G. A. Kosm. Issled., 5: 420-30(May-June 1967). (In Russian).

The effective cross section of the inelastic interactions of protons with carbon nuclei was measured with the Proton-1 and Proton-2 in the energy interval from 10^{10} to 10^{12} eV. The size of σ_{p-C} was 221 ± 3 mb in the energy interval from 1.6 to 3.6×10^{10} eV, 227 ± 4 mb in the energy interval from 4.4 to 8×10^{10} eV, 242 ± 3 mb at energy interval from 1.2 to 2.2×10^{11} eV, and 270 ± 5 mb at energy interval from 4 to 6×10^{11} eV. The magnitude of σ_{p-C} at energy of 1.1×10^{12} eV is 256 ± 15 mb. A 20% increase was registered with a change of the proton energy from 10^{10} to 10^{12} eV. (tr-auth)

22551 PRODUCTION OF ^8He IN THE π^- MESON CAPTURE BY CARBON, NITROGEN, AND OXYGEN NUCLEI. Batusov, Yu. A.; Bunyatov, S. A.; Sidorov, V. M.; Yarba, V. A. (Joint Inst. for Nuclear Research, Dubna, USSR). Yadern. Fiz., 7: 28-30(1968). (In Russian).

Events of the ^8He production and decay resulting from the π^- meson capture by carbon, nitrogen, and oxygen nuclei were detected in photoemulsions. The relative probability of the ^8He production is found to be $8.0 \pm 2.5 \times 10^{-4}$ for carbon, $\sim 0.8 \times 10^{-4}$ for oxygen, and $\sim 2 \times 10^{-4}$ for nitrogen. The mass of the ^8He atom was measured to be 7482.5 ± 0.4 MeV. The mass excess M − A = 31.0 ± 0.4 MeV. (auth)

22552 POLARIZATION OF NEUTRONS AND PROTONS IN ^{12}C STRIPPING. Babenko, N. P.; Gridnev, K. A.; Nemilov, Yu. A. Yadern. Fiz., 7: 22-7(1968). (In Russian).

By means of the distorted-wave method the nucleon polarization from ^{12}C stripping was calculated. The dependence of polarization on the change of parameters and form-factors of the distorting potentials and on the change of deuteron energy E_d was investigated. It is shown that the distorted-wave theory correctly represents the angular and energetic dependence of polarization even not taking into account spin-orbit forces in potentials at $E_d < 11.8$ MeV and $\theta < 80$ to 90°. (auth)

22553 ORIGIN OF NEUTRON GROUPS IN Be(α,n) SOURCES. Lehman, R. L. (Univ. of California, Los Angeles). Contract AT(04-1)-Gen-12. Nucl. Instrum. Methods, 60: 253-60(Apr. 1968). (UCLA-12-665).

The neutron spectra of an 80 g PuBe source and an 11 Ci PoBe source were measured by differentiation of proton track distributions sampled from nuclear emulsion. Special analysis of the track distributions revealed peaks at 0.54, 0.78, 1.1, 2.3, 3.2, 4.8, 5.6, 7.8 and 9.8 MeV in both spectra. The common features and the differences in the two sources are interpreted by use of a numerical graphical analysis based on published differential and integral cross sections for the $^9Be(\alpha,n)$ reaction. In contrast to earlier theoretical and semiempirical attempts, this analysis successfully explains the major features of various measured $^9Be(\alpha,n)$ source neutron spectra. Partial-wave (resonance) theory predictions of the reaction anisotropy of the neutron groups in such spectra are made and discussed. (auth)

22554 QUASI-FREE α-α SCATTERING IN ^9Be AND ^{12}C AT 37 MeV. Yanabu, Takuji (Kyoto Univ.); Yamashita, Sukeaki; Hosono, Kazuhiko; (and others). J. Phys. Soc. Jap., 24: 667-77 (Apr. 1968).

Energy and angular correlations between two alpha particles from the reactions $^9Be(\alpha,2\alpha)^8He$ and $^{12}C(\alpha,2\alpha)^8Be$ were investigated. The incident alpha-particle energies were 32.3 and 37.4 MeV for ^9Be and 37.4 MeV for ^{12}C. It is concluded that the quasi-free scattering of incident alpha particles from alpha clusters in ^9Be is the main process of the $(\alpha,2\alpha)$ reaction on ^9Be. There remains some ambiguity for the mechanism of the $(\alpha,2\alpha)$ reaction on ^{12}C. (auth)

22555 ELASTIC SCATTERING OF OXYGEN IONS BY ^{10}B AND ^{11}B. Okuma, Yasuhiko (Kyoto Univ.). J. Phys. Soc. Jap., 24: 677-89(Apr. 1968).

Elastic scattering measurements were carried out on $^{16}O + ^{10}B$ and $^{16}O + ^{11}B$ systems using beams of ^{16}O ions of precisely defined energy from the Kyoto University tandem accelerator. Measurements were made for energies near and above the Coulomb barrier appropriate to each system. The scattering particles were identified by means of the two-dectors fast-slow type coincidence system. The angular distributions for $^{16}O + ^{10}B$ scattering show a smooth angular dependence, but in the case of those for $^{16}O + ^{11}B$ scattering, diffraction structure was observed. The excitation curves of both systems have a smooth, nearly monotonic, energy dependence. A complex optical potential model has been used to describe the elastic scattering data. Using a Woods–Saxon form for both the real and imaginary potentials, fairly good agreement with the experimental data was obtained. The imaginary part of potentials increases with energy (about a MeV per MeV) in the energy range studied. There is one difference of the imaginary potential of 2 MeV as a whole in two scattering systems. (auth)

22556 BEHAVIOUR OF THE ANGULAR CORRELATION SYMMETRY ANGLE FOLLOWING INELASTIC SCATTERING OF ^3He PARTICLES FROM ^{12}C. Assousa, G. E.; Lasalle, R. A.; Ahlfeld, C. E.; Van Rinsvelt, H. A.; Heydenburg, N. P. (Florida State Univ., Tallahassee). Phys. Lett., 26B: 503-5(Mar. 18, 1968).

The in-plane angular correlation study of the reaction $^{12}C(^3He, ^3He'\gamma_{4.43})^{12}C$ is discussed. The behavior of the symmetry angle is presented and is compared with the behavior of the symmetry angle for α'-γ and p'-γ angular correlations. (auth)

22557 GROUND-STATE ELECTROMAGNETIC WIDTHS OF THE 6.32-MeV LEVEL IN ^{15}N. Beer, G. A.; Brix, P.; Clerc, H.-G.; Laube, B. (Technische Hochschule, Darmstadt, Ger.). Phys. Lett., 26B: 506-7(Mar. 18, 1968).

Inelastic scattering of 50-, 53-, and 57-MeV electrons was used to determine $\Gamma_\gamma^0(M1) = 3.4 \pm 0.7$ eV and $\Gamma_\gamma^0(E2) = 0.06 \pm 0.02$ eV for the 6.32-MeV level in ^{15}N. (auth)

22558 THREE BODY DECAY OF THE 1.71-MeV (2^+) STATE OF ^6He. Ewers, W. M.; Kuemmel, H. (Max-Planck-Institut fuer Chemie, Mainz). Phys. Lett., 26B: 480-1(Mar. 18, 1968).

A generalization of the α-decay theory to three body decays, assuming a two-step process, was formulated and was applied to the energy distribution of the decay products of the 1.71-MeV state of ^6He as a function of the neutron-neutron scattering length. (auth)

Nuclear Properties and Reactions, $20 \leq A \leq 89$

Refer also to abstracts 21051, 21976, 22272, 22301, 22523, 22548, 22587, 22589, 22590, 22594, 22614, 22629, 22631, 22635, and 22639.

22559 (NP-17384) AN EXPERIMENTAL AND THEORETICAL STUDY OF THE ^{40}Ca LEVEL SCHEME. Leenhouts, Hendrik Pieter (Utrecht Rijksuniversiteit (Netherlands)). 1967. 53p. Dep.

Thesis.

I. In the proton energy range E_p = 500 to 2900 keV, fifty-three resonances were observed in the $^{39}K(p,\gamma)^{40}Ca$ reaction. The resonance energies and strengths were determined. The decay modes of most of the resonances and of fifteen lower excited states in ^{40}Ca were determined from single and coincidence gamma-ray spectra. II. Gamma-gamma triple angular correlation measurements were performed at eight resonances, and polarization experiments at three resonances of the $^{39}K(p,\gamma)^{40}Ca$ reaction in the proton energy range E_p = 1.1 to 2.1 MeV. Spins and parities could be determined of the following ^{40}Ca levels (energies in MeV): 3.73, 3^-; 3.90, 2^+; 4.48, 5^-; 5.24, 2; 5.27, 4^+; 5.61, 4^-; 6.28, $3^{(-)}$; 6.94, (1, 2); 7.29, 0; 7.49, 2; 9.41, 2; 9.61, 3^+; 9.65, 2^-; 9.79, 3; 9.87, 1; 9.96, 4^+; and 10.33 1. In addition, a number of gamma-ray multipole mixing ratios in ^{40}Ca were determined. A shell model calculation was made with the surface delta interaction to explain the odd-parity levels. (auth)

22560 (ORO-1067-2) PROGRESS REPORT [ON NUCLEAR PHYSICS]. (Duke Univ., Durham, N. C. Nuclear Structure Lab.). Dec. 31, 1967. Contract AT(40-1)-1067. 55p. Dep. CFSTI.

The cross sections of several neutron-induced and charged particle-induced reactions were investigated, and information on the excited states of several nuclei was obtained. The neutron total cross sections of a number of isotopes and the average neutron total cross sections of several elements and compounds were measured. Optical-model analyses of reaction cross sections were performed, and the J dependence of angular distributions for (He-3,α) reactions on light nuclei was studied using the diffraction

model. The development of a windowless gas target chamber and the status of a Van De Graaff tandem accelerator using a cyclotron injector are also reported. (D.C.W.)

22561 (ORNL-tr-1850) THE ^{64}Zn(n,p)^{64}Cu REACTION WITH 14-MeV NEUTRONS. ENERGY AND ANGULAR DISTRIBUTIONS OF PROTONS FROM ^{64}Zn BOMBARDED BY 14-MeV NEUTRONS. Fujita, Iwao. Translated for Oak Ridge National Lab., Tenn., from Kyushu Daigaku Kogaku Shuho, 37: 294-9(1965). 20p. Dep. CFSTI. JCL $1.60 fs, $0.80 mf.

Neutrons of 14-MeV energy were bombarded on zinc to bring about the ^{64}Zn(n,p) reaction; and the emitted proton energy distribution, proton angular distribution, and reaction cross section were determined using dry nuclear emulsion plates. The backward scattering of protons could be described by statistical theory. The nuclear temperature of (n,p) and (n,np) reactions through compound nuclei was 1.16 ± 0.08 MeV and 0.44 ± 0.02 MeV, respectively. The reaction cross sections were 159 ± 27 and 221 ± 48 mb, respectively. The contribution from the direct process was 51 mb. (auth)

22562 NUCLEAR STRUCTURE OF ^{40}Ca AND ELASTIC SCATTERING OF 750-MeV ELECTRONS. Khanna, F. C. (Chalk River Nuclear Labs., Can.). Phys. Rev. Lett., 20: 871-3 (Apr. 15, 1968).

It is shown that inclusion of the short-range nucleon-nucleon correlations in the usual shell-model description can provide adequate agreement with the known results of the electron elastic-scattering cross section and can make some interesting predictions. (auth)

22563 INTERMEDIATE STRUCTURE IN THE PHOTODISINTEGRATION OF NICKEL. Costa, S. (Univ., Turin. Istituto Nazionale di Fisica Nucleare, Turin); Manfredotti, C.; Pasqualini, L.; Ferrero, F. Nuovo Cim., 54B: 344-5(Apr. 11, 1968).

The photoneutron cross section of natural nickel was measured at bremsstrahlung energies of 11 to 34 MeV. The experimental data were compared with theoretical predictions in which the intermediate structure is attributed to the interaction of the giant-dipole oscillations with the surface quadrupole vibration and in which the single-particle features of the giant resonance are taken into account. (D.C.W.)

22564 NEW ISOMER OF ^{40}Cl: 0.10-s ^{40m}Cl. Flammang, N. K.; Reising, R. F. (McDonnell Co., St. Louis). Nuovo Cim., 54B: 349-51(Apr. 11, 1968).

A liquid-argon activation detector was exposed to 17-MeV neutrons from the ^{9}Be(d,n)^{10}B reaction. Scintillations in the liquid argon were registered by a photomultiplier, the output of which was fed into a 400-channel analyzer that can be operated in either the time analysis (TA) or pulse-height analysis (PHA) mode. The TA data revealed four components with half-lives of 25, 0.75, 0.10, and 0.016 sec; the 0.10-sec activity was attributed to ^{40m}Cl. This interpretation was corroborated by replacing the liquid argon with an organic liquid scintillator, which showed the presence of only the 25-, 0.75-, and 0.016-sec activities. An unsuccessful attempt was made to observe γ rays resulting from the decay of ^{40m}Cl. (D.C.W.)

22565 INELASTIC SCATTERING OF DEUTERONS FROM ^{56}Fe. Majumder, A. R.; Sen Gupta, H. M. (Univ. of Dacca, East Pakistan). Aust. J. Phys., 21: 235-7(Apr. 1968).

The energy levels of ^{56}Fe were investigated by deuteron inelastic scattering at 12 MeV. The scattered deuterons were detected at 24 angles from 5 to 175° in Ilford K2 emulsion. Spin-parity assignments of 2^+, 4^+, and 3^- were confirmed for the 0.844-, 2.077-, and 4.503-MeV levels; a tenative assignment of 6^+ was made for the 4.450-MeV level. The angular distributions for the 2^+ and 3^- states were analyzed in terms of the diffraction model of Blair, and the surface deformation parameters were extracted from the normalized cross sections. (D.C.W.)

22566 MULTIPOLARITY OF THE 341-keV TRANSITION ACCOMPANYING CAPTURE OF THERMAL NEUTRONS BY ^{48}Ti. Tret'yakov, E. F.; Danilyan, G. V.; Pavlov, V. S.; Grishuk, G. I.; Konyaev, V. F. (Inst. of Theoretical and Experimental Physics, Moscow). Yadern. Fiz., 7: 7-12(1968). (In Russian).

The internal conversion coefficient (ICC) for the 341-keV transition accompanying the capture of thermal neutrons by ^{48}Ti was measured. The quantity obtained, $\alpha = 0.95 \pm 0.14 \times 10^{-3}$ coincides within the errors with the value of α for the M1 transition. This result taken in combination with the available data on the angular correlations, makes it possible to choose the value −0.1 between two possible values of the mixing parameter δ (+2.2 and −0.1). Control experiments were made in order to test the method used in absolute measurements of ICC; ICC for the 323-keV transition in ^{51}V was determined ($\alpha = 1.45 \pm 0.14 \times 10^{-3}$), as well as the intensity of the 341-keV transition in ^{49}Ti per captured neutron ($\nu = 0.33 \pm 0.08$). (auth)

22567 EXCITATION OF THE GIANT RESONANCE IN ^{28}Si BY MEANS OF THE INELASTIC ELECTRON SCATTERING. Afanas'ev, N. G.; Gul'karov, I. S.; Savitskii, G. A.; Khvastunov, V. M.; Shevchenko, N. G. Yadern. Fiz., 7: 13-21(1968). (In Russian).

Highly excited states of ^{28}Si with energies from 10 to 30 MeV were investigated by means of electrons with high energy. The transition to the 12.7 ± 0.2-MeV level is the E2 transition, and the transition to the 15.0 ± 0.2 MeV level is the E2 or E1 transition. The giant dipole resonance has the half-width of 4.6 ± 0.4 MeV and a mean excitation energy of 19.2 ± 0.2 MeV. The data on the giant resonance are compared with predictions of the Goldhaber–Teller model and with predictions of the oscillating liquid drop model. (auth)

22568 ON THE CHARGE DENSITY DISTRIBUTION AND RADIUS OF THE NUCLEI ^{40}Ca AND ^{48}Ca. Nemirovskii, P. E. Yadern. Fiz., 7: 53-6(1968). (In Russian).

Experiments on the charge distribution in the nuclei ^{40}Ca and ^{48}Ca are discussed. It is shown that the shell model with a potential describing light and heavy nuclei is able to explain 75% of the observed effect in the difference between the differential cross sections of the electron scattering on ^{40}Ca and ^{48}Ca. A slight decrease of the diffusion for ^{48}Ca as compared with ^{40}Ca is in full agreement with the experiment. The range of the potential and the radius of the nucleon distribution increase as $A^{\frac{1}{3}}$ due to the increase of the neutron density in the outer shell of the nucleus. (auth)

22569 A NOTE ON THE IONIZATION DEFECT OF HEAVY IONS. Morgenstern, H. (Hahn-Meitner-Institut fuer Kernforschung, Berlin). Nucl. Instrum. Methods, 60: 357(Apr. 1968).

The ionization defect of ^{27}Al recoils emitted in the reaction ^{28}Si(n,d)^{27}Al is measured as a function of recoil energy. (auth)

22570 SOME STUDIES OF THE ^{23}Na + p REACTION AT E_p = 2.2 TO 4.5 MeV. Hiratate, Yukio; Takeuchi, Yuzo; Yamaya, Takashi; Morita, Susumu (Tohoku Univ., Sendai). J. Phys. Soc. Jap., 24: 690-7(Apr. 1968).

Excitation curves were measured for the ^{23}Na(p,α_0)^{20}Ne reaction in the proton energy range of 2.2 to 4.5 MeV at θ_{lab} = 135° and also 2.8 to 4.5 MeV at θ_{lab} = 90°. The yield of gamma rays accompanying the ^{23}Na(p,α_1)^{20}Ne and ^{23}Na(p,p_1)^{23}Na reactions was measured in the energy ranges 2.48 to 2.80 MeV and of 3.56 to 4.50 MeV. Thirteen angular distributions for the α_0 group were obtained in the range of 2.27 to 3.63 MeV. Most of these distributions are asymmetric about 90° (cms). The angular distributions in the range of 2.27 to 4.45 MeV were analyzed in terms of the Legendre polynomial. Four resonances were found at 2.29, 2.31, 2.42, and 2.44 MeV, and the last two resonances were analyzed to be 4^+ and 1^- respectively. The excitation curves in the range of 2.76 to 4.50 MeV are analyzed by the fluctuation theory, and the coherence width for the compound nucleus was found to be about 50 keV. (auth)

22571 RESONANCE SCATTERING OF GAMMA RAYS BY COPPER. Tumbev, G. Khr. Compt. Rend. Acad. Bulg. Sci., 20: 541-3(1967). (In Russian).

Gamma rays from the capture of thermal neutrons can be used to investigate resonance scattering in the region of 6 to 9 MeV. The advantage of using monochromatic gamma rays for investigating resonance scattering is obvious in this case where excitation of only one level is to be expected. Resonance scattering by copper was observed with the use of TiO_2 having a weight of 1350 g as a source of gamma rays. Source and scatterer were natural isotopic mixtures. Resonance gamma rays having an energy E_{gamma} = 6.41 MeV showed an increased count rate due to nuclear resonance scattering of gamma rays from Ti on Cu. Control experiments were carried out with the source and without it. The cross-section for the gamma ray resonance scattering $\sigma_{\gamma\gamma}$ was determined from the count rates under the 6.41 MeV photopeaks at different reactor power levels for a 4 in. × 6 in. NaI(Tl) crystal. The value of $\sigma_{\gamma\gamma}$ was found to be 16.6 ± 3.4 mb. Since a natural mixture of copper isotope was used as the scattering agent, it was not possible to determine whether ^{63}Cu or ^{65}Cu scattered the 6.41-MeV gamma rays by resonance. (TTT)

22572 GAMMA-GAMMA ANGULAR CORRELATION IN ^{75}Se. Prasad, Rajendra; Sehgal, M. L. (Aligarh Muslim Univ., India). J. Phys. Soc. Jap., 24: 663-6(Apr. 1968).

Gamma-gamma angular correlations for the five cascades 121–280 keV, 136–265 keV, 66–199 keV, 136–199 keV and 136–66 keV following the decay of ^{75}Se were studied using the

coincidence method. The 66–199 keV and 136–199 keV gamma-gamma angular correlations are found to be consistent with the spin $\frac{1}{2}$ for the 199-keV level in ^{75}As. (auth)

22573 SOME EXCITATION FUNCTIONS OF NEUTRON-INDUCED REACTIONS AROUND 14 MeV. Cuzzocrea, P. (Univ. Naples. Istituto Nazionale di Fisica Nucleare, Naples); Perillo, E.; Notarrigo, S. Nuovo Cim., 54B: 53-60(Mar. 11, 1968).

Excitation functions of some (n,p), (n,2n) and (n,α) reactions usually employed as standard monitors were measured by activation in the neutron energy range 13.70 to 14.67 MeV with an energy spread of ≈50 keV. The results were compared with the best fits obtained for the same reactions from the known data in the range 12.8 to 15.5 MeV. A good agreement was generally found. Fluctuations about the mean values were observed. (auth)

22574 STATISTICAL FLUCTUATION ANALYSIS OF THE ^{25}Mg(^{3}He,α)^{25}Mg REACTION. Rubbino, A. (Univ., Catania, Italy. Istituto Nazionale di Fisica Nucleare, Catania, Italy). Nuovo Cim., 54B: 37-52(Mar. 11, 1968).

The reaction ^{25}Mg(^{3}He,α) was studied at $E_{^3He}$ = 4 to 6 MeV for the α_0, α_1, α_2, α_3, and α_4 groups. The excitation functions were measured in steps of 50 keV with ^{3}He energy resolution better than 25 keV and at angles between 15 and 165° in steps of 7.5°. The data were analyzed on the basis of statistical fluctuation theory, obtaining information on some nuclear parameters. Methods of statistical mathematics not so far utilized on the fluctuation analysis have been used in order to evaluate the compound-nucleus contribution in the presence of large direct effects. (auth)

22575 HALF-LIFE OF ^{54}Mn. Zimmer, W. H. (Atlantic Richfield Hanford Co., Richland, Wash.); Dahl, R. E. Nucl. Sci. Eng., 32: 132-3(Apr. 1968).

A total of 1038 determinations of the half-life of ^{54}Mn were made using gamma scintillation spectrometry in an attempt to characterize 3 in. × 3 in. NaI(Tl) spectrometers. Eight-hundred and thirty determinations were statistically analyzed; an overall average half-life of 312.99 days with an uncertainty of ±0.10 days at the 95% confidence level was obtained. (D.C.W.)

22576 EXCITATION OF NON-NORMAL PARITY STATES IN INELASTIC PROTON SCATTERING. Reif, R. (Central Inst. of Nuclear Research, Rossendorf, Ger.); Slotta, J.; Hoehn, J. Phys. Lett., 26B: 484-8(Mar. 18, 1968).

DWBA calculations (differential cross section and polarization) of the inelastic proton scattering exciting nonnormal-parity states in ^{16}O(2$^-$, 8.88 MeV), ^{28}Si(3$^+$, 6.27 MeV), and ^{32}S(1$^+$, 4.70 MeV) were performed assuming a pure spin-flip mechanism and using a mixture of 1p1h configurations for the wave functions of the final states. (auth)

22577 LIFETIME MEASUREMENTS IN ^{41}Ca AND ^{29}Si. Baker, Samuel Israel. Chicago, Illinois Institute of Technology, 1967. 172p.

Thesis.

The attenuated-Doppler-shift method for measuring nuclear lifetimes was used for the study of the ^{41}Ca and ^{29}Si nuclei. The recent development of the Ge(Li) detector for precise determinations of gamma-ray energies resulted in the selection of this method. The shell model of Mayer and Jensen predicts that ^{41}Ca consists of one neutron outside of closed shells for protons and neutrons, and ^{29}Si consists of one neutron outside of closed subshells. Hence, the low-lying energy levels should be of a simple nature. However, this is not the case even for ^{41}Ca. The first shell-model state expected above the ground state appears as at least a doublet. The lifetimes of the doublet were measured, obtaining a mean life of $(4.6^{+1.0}_{-1.3}) \times 10^{-13}$ sec for the first excited state and a limit of greater than or equal to 7×10^{-13} sec for the third excited state. This information, coupled with the branching ratio for the third excited state, shows that the reduced transition probability for the first excited state is much greater than for the third. Gerace and Green were able to account for this by allowing a set of deformed states from excitations of the ^{40}Ca core to mix with the single-particle states. For ^{29}Si the situation is more complicated. Two of the first four excited states of ^{29}Si are $\frac{3}{2}$ states which could indicate a splitting of the single-particle state by analogy with the ^{41}Ca case; however, the ^{28}Si(d,p) reaction indicates that only the lowest-lying $\frac{3}{2}^+$ state has much single-particle strength. The high Q value of this reaction makes it possible to excite the first four plus several higher states at a low bombarding energy. By detecting the protons in coincidence with the gamma rays, selecting the proper energy level based on the proton energy, and sorting the gamma-ray energy information for protons detected at two different angles, measurements were made of the lifetimes of the first four energy levels simultaneously. The results were $(2.15 \pm 0.95) \times 10^{-13}$ sec for the first excited state, $(2.7^{+1.1}_{-1.3}) \times 10^{-13}$ sec for the second, $<1.4 \times 10^{-13}$ sec for the third, and $<1.4 \times 10^{-13}$ sec for the fourth. The lifetimes given above coupled with the branching ratios determined by Becker et al. and the E2/M1 mixing ratios measured by Becker et al. and by McCallum result in E2 transition probabilities which are approximately ten times the single-particle estimates of Moszkowski. These values for E2 transitions are characteristic of enhanced transitions in the s-d shell, i.e., the transition rate is increased by collective modes involving the motions of more than one particle (nucleon) in the nucleus. (Disser. Abstr.)

Nuclear Properties and Reactions, A ≥ 90

Refer also to abstracts 21051, 21092, 21325, 22272, 22523, 22530, 22573, 22629, 22631, and 22635.

22578 (IA–1152) NUCLEAR DATA FOR ^{240}Pu, ^{241}Pu, and ^{242}Pu. Yiftah, S.; Schmidt, J. J.; Caner, M.; Segev, M. (Israel Atomic Energy Commission, Yavne. Soreq Nuclear Research Center). Dec. 1967. 100p. Dep.

An evaluation of the basic nuclear data for ^{240}Pu, ^{241}Pu, and ^{242}Pu in the range 0.01 eV to 15 MeV was made. Partial cross sections are constructed for the thermal and fast neutron ranges; they are presented in graphical and tabular form. Resonance parameters and average parameters are recommended for the resonance region; they are presented in tabular form. The cross sections constructed are: total, nonelastic, elastic scattering, radiative capture, fission, total and partial inelastic scattering, (n,2n), and (n,3n). Other nuclear data considered are: the average parameters above 1 keV, the average number of prompt neutrons per neutron-induced fission, the average scattering cosine in the lab system, and the energy spectrum of secondary neutrons from fission. (auth)

22579 (IPNO/TH–114) QUASI-PARTICLE DESCRIPTION OF 2^+ AND 3^- STATES OF EVEN–EVEN SPHERICAL NUCLEI. Lombard, R. J. (California Univ., La Jolla, San Diego). [1967]. 35p. Dep. CFSTI.

The description of the first 2^+ and 3^- level of spherical nuclei $90 \leq A \leq 150$ and $186 \leq A \leq 206$ is performed in the framework of the BCS theory. The residual interaction is taken as the superposition of the pairing force and of the multipole force. The short-range proton-neutron correlations are neglected. In addition to the valence nucleons, the core particles are taken into account; it allows the computation of the transition probabilities without any effective charge. Theoretical predictions concerning the E_{2+} and E_{3-} energies, the B(E2) and B(E3) reduced transition probabilities and the gyromagnetic factors g_{2+} are in good agreement with experiment. (auth)

22580 (JINR–P3–3696) SPEKTRY γ-LUCHEI IZ ZAKHVATA REZONANSNYKH NEITRONOV NA IZOTOPAKH Ba I Pr. (γ-Ray Spectra from the Resonance Neutron Capture in Ba and Pr). Bechvarzh, F.; Vrza, Ya.; Liptak, Ya.; Urbanec, Ya. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics). 1968. 25p. (In Russian). Dep.

With the help of a high-resolution spectrometer, the γ-ray spectra following the neutron capture in ^{139}Ba and ^{141}Pr were measured. On the basis of the results obtained, conclusions were drawn about the character of intensive primary transitions for the 24.5-eV resonance of ^{139}Ba and about the character of the resonances in ^{141}Pr as well. (auth)

22581 (JINR–P3–3697) GAMMA-SPEKTR IZ RADIATSIONNOGO ZAKHVATA NA Cs. (γ-Ray Spectrum from the Radiative Capture in Cs). Bechvarzh, F.; Vrzal, Ya.; Liptak, Ya.; Urbanec, Ya. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics). 1968. 14p. (In Russian). Dep.

The measurements of the γ-ray spectra, following the resonance neutron capture in ^{133}Cs, performed with the aid of the Ge(Li) detector of active volume about 12 cm^3, are described. The energies and intensities of a number of transitions have been obtained. (auth)

22582 (JINR–P7–3710) NABLYUDENIE IZOTOPOV POLONIYA I ASTATINA V OSKOLKAKH DELENIYA PRI OBLUCHENII ^{238}U IONAMI ^{20}Ne I ^{40}Ar. (Observation of the Po and At Isotopes in the Fission Fragments When Bombarding ^{238}U With the ^{20}Ne and ^{40}Ar Ions). Kuznetsov, I. V.; Mal'tseva, N. S.; Oganesyan, Yu. Ts.; Sukhov, A. M.; Shchegolev, V. A. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Nuclear Reactions). 1968. 15p. (In Russian). Dep.

The yields of the ^{204,206,208,210}Po and the ^{207,209,211}At isotopes are measured in the fission fragments when bombarding ^{238}U with the

^{20}Ne and ^{40}Ar ions. The control experiments exclude the possibility of production of the mentioned isotopes in stripping reactions. The data are given on the production of the ^{211m}Po and ^{212m}Po isomers in the fission fragments. The experimental data are discussed from the point of view of the cascade fission. The possibility of the isotope synthesis in stripping reactions is pointed out. (auth)

22583 (JINR-P7-3733) K VOPROSU O STABIL'NOSTI SVERKHTYAZHELYKH YADER. (To the Problem of the Stability of Superheavy Nuclei). Muzychka, Yu. A.; Pashkevich, V. V.; Strutinskii, V. M. (Joint Inst. for Nuclear Research, Dubna (USSR)). 1968. 11p. (In Russian). Dep.

Shell corrections and the deformation energies for a number of superheavy nuclei were calculated. (auth)

22584 (LA-DC-9181) ^{238}U NEUTRON CAPTURE RESULTS FROM BOMB SOURCE NEUTRONS. Glass, N. W.; Schelberg, A. D.; Tatro, L. D.; Warren, J. H. (Los Alamos Scientific Lab., N. Mex.). [1967]. Contract W-7405-eng-36. 16p. (CONF-680307-20). Dep. CFSTI.

From 2nd Conference on Neutron Cross Sections and Technology, Washington, D. C.

Results on neutron capture in ^{238}U from 30 to 2050 eV neutron energy are presented. The data were obtained by neutron time-of-flight utilizing the pulse source of neutrons from the Petrel nuclear explosion. The total radiation width, Γ_γ, was determined for 62 l = 0 levels with $\bar{\Gamma}_\gamma = [19.1 \pm 0.6 \text{ (stat.)} \pm 1.4 \text{ (syst.)}] \times 10^{-3}$ eV. There appears to be a significant variation in the value of Γ_γ from resonance to resonance. Approximately 200 weak resonances were found which can be ascribed to p-wave levels. Analysis of these weak resonances, assuming l = 1, gives results consistent with: an average reduced neutron width of $3.7 \pm 0.7 \times 10^{-3}$ eV; an average level spacing of 7.0 ± 0.5 eV; and a strength function of $1.8 \pm 0.3 \times 10^{-4}$. (auth)

22585 (LA-DC-9182) CAPTURE CROSS SECTION MEASUREMENTS FOR Lu, ^{151}Eu, AND ^{153}Eu AND THE TOTAL CROSS SECTION OF Eu. Harlow, M. V.; Schelberg, A. D.; Tatro, L. D.; Warren, J. H.; Glass, N. W. (Los Alamos Scientific Lab., N. Mex.). [1966]. Contract W-7405-eng-36. 10p. (CONF-680307-21). Dep. CFSTI.

From 2nd Conference on Neutron Cross Sections and Technology, Washington, D. C.

Neutron capture cross sections of Lu, ^{151}Eu, and ^{153}Eu were measured between 0.025 and 10 keV by time-of-flight techniques with neutrons resulting from the underground detonation of a nuclear device. Experimental details, capture cross-section results, and total cross-section results derived from these measurements are presented. (auth)

22586 (NP-17325) DELENIE YADER FOTONAMI I ELEKTRONAMI VYSOKIKH ENERGII. (Fission of Nuclei by High-Energy Photons and Electrons). Ranyuk, Yu. N. (Akademiya Nauk Ukrainskoi SSR, Kharkov. Fiziko-Tekhnicheskii Institut). 1967. 63p. (In Russian). Dep.

Thesis.

The photofission reaction is a partial case of the interaction of photons with nuclei, based primarily on a wavelength-dependent absorption mechanism. The problem was approached by studying the fission of Be, Pb, ^{206}Pb, ^{207}Pb, ^{208}Pb, Tl, Au, Pt, Os, Re, Ta, Hf, and Sm nuclei by >1600-MeV photons; the fission thresholds of these nuclei lie above the giant resonance energy. The wide range of masses used allowed to clarify the photofission cross section as a function of the mass of the target nucleus. The isotopic lead targets were used to examine the effect of the nuclear shell structure on the photofission at high photon energies. The fission of uranium by 35-to 260-MeV electrons was also investigated because of the high photofission cross section of this nucleus. The angular distribution of the photofission products of Bi, Pb, Au and Pt, measured at photon energies from 100 to 260 MeV were found to be isotropic within 5%. The lack of marked anisotropy may be due to the fact that the fissioning nucleus is formed by the emission of a large number of nucleons as the result of nuclear cascades and evaporation. The photofission studies were carried out on the 360-MeV and 2-GeV linear electron accelerators of the Kharkov Physico-Technical Institute; for the electron-induced fission studies, the 360-MeV electron accelerator was used. (TTT)

22587 (NP-17386) TRANSITION RATES IN MEDIUM AND HEAVY NUCLEI. Experimental Studies with Theoretical Interpretations. Malmskog, Sven G. (Stockholm Univ. (Sweden)). 1967. 360p. Dep.

Thesis.

A collection of 24 papers that have appeared either in Nuclear Physics or in Arkiv for Fysik is presented. The papers deal with the experimental determination and theoretical analysis of single-particle transition rates in deformed nuclei and in nuclei outside the deformed regions. The development of the γ coincidence system, the rabbit system, and the long-lens electron-electron coincidence spectrometer that were used in the measurements is discussed in some of the papers. (D.C.W.)

22588 (ORO-1797-11, pp 114-64) FISSION. (Florida State Univ., Tallahassee. Dept. of Chemistry).

The distribution of nuclear charge in fission was investigated by measuring mass yield curves for deuteron- and proton-induced fission of ^{232}Th and ^{238}U. Cross sections for the production of specific isotopes were also determined. (D.C.W.)

22589 (ORO-3346-18) MEASUREMENTS BY IMPROVED METHODS OF ACTIVATION CROSS SECTIONS FOR 14.4 MeV NEUTRON REACTIONS. Fink, R. W. (Georgia Inst. of Tech., Atlanta. School of Chemistry). Feb. 26, 1968. Contract AT(40-1)-3346. 21p. (CONF-680411-1). Dep. CFSTI.

From Conference on Small Accelerators, Oak Ridge, Tenn.

The development of improved techniques for precision measurement of activation cross sections is reported. These new techniques take advantage of the high resolution of Ge(Li) detectors. For short-lived products, a fast pneumatic transport system (≈800 msec) is used, together with a digital tape recorder to store rapid, successive 400-channel spectra from rapidly decaying samples observed with a 16-cc Ge(Li) spectrometer. Precision cross sections for reactions of isotopes of Kr, Si, Zn, Br, Rb, Se, Fe, Ge, Cd, Pd, Hg, Tl, and Au are tabulated. These values are being fitted into a revised system of cross section systematics, from which all questionable early data are excluded. Current work on Xe isotopes and other elements is discussed. Improvements in the operation of a 200 kV accelerator are reported, and its proposed use as a source of bremsstrahlung-free characteristic x rays for atomic physics investigations and for high-resolution (medical) x-ray photography is pointed out. (auth)

22590 (PUC-937-291) NUCLEAR POLARIZATION IN MUONIC ATOMS. Chen, Min-yi (Princeton Univ., N. J. Palmer Physical Lab.). Jan. 1968. Contract AT(30-1)-937. 99p. Dep. CFSTI.

Thesis.

The nuclear polarization effect in muonic atoms is calculated for ^{208}Pb, ^{40}Ca, and ^{238}U. The nuclear intermediate states of ^{208}Pb are collective particle-hole states calculated from realistic nucleon-nucleon forces. The total effect is an increase of binding of 5.5 to 6.5 keV for the 1s level and 2.0 keV for the 2p level. The uncertainty comes from the lack of knowledge of 0^+ breathing excitations. Similar calculations for ^{40}Ca give the correction to the 1s level as ~0.2 keV. Henley and Cooper's closure approximation, which leads to a large correction of 58 keV to the ^{208}Pb 1s level, is repeated with two improvements: the intermediate muonic states in the continuum are treated properly and the two nucleon cross terms in the ground state nucleus are included. The correction then comes down to the same order of magnitude. The rigid rotator model is used for the deformed ^{238}U. The correction to the 1s level from the quadrupole coupling with low-lying rotational nuclear states and d muonic states is 6.4 keV. For the $2p_{\frac{1}{2}}$ level, the correction from muonic intermediate states outside of the spin doublet $2p_{\frac{1}{2}} - 2p_{\frac{3}{2}}$ is 1.9 keV. In all cases the continuous spectrum of the muon contributes most of the correction. The reference spectrum method is used throughout the calculation. (auth)

22591 (RISO-167) PARITY-NON-CONSERVATION IN NUCLEAR FORCES STUDIED BY THE CAPTURE OF POLARIZED THERMAL S-NEUTRONS. Warming, Elisabeth (Danish Atomic Energy Commission, Risoe, Research Establishment). Sept. 1967. 34p. Dep.

The asymmetry A in the γ intensity after the capture of polarized thermal s-wave neutrons in ^{113}Cd was investigated with a view to searching for a parity-nonconserving nuclear force. The upper limit for A was determined at $|A| < 4.7\ 10^{-4}$. (auth) (DENMARK)

22592 (RPI-328-112, pp 1-15) NEUTRON CROSS SECTIONS. (Rensselaer Polytechnic Inst., Troy, N. Y.).

Experimental data on neutron capture in metallic samples of ^{182}W, ^{183}W, ^{184}W, and ^{186}W were taken with a 1.25-m-diameter capture tank and a time-of-flight resolution of 2 nsec/m. At least 9 previously unreported resonances in ^{182}W at 0.225 to 4 keV, 36 resonances in ^{183}W at 0.180 to 2.6 keV, 12 resonances in ^{184}W at 0.145 to 4 keV and 8 resonances in ^{186}W at 0.350 to 4 keV were observed. In addition, previously reported single resonances were resolved in doublets at 3434 and 4005 eV in ^{182}W and at 1012, 1402, and 1698 eV in ^{183}W. A supervisor program was written for data acquisition and processing with a PDP-7 computer. (D.C.W.)

22593 SHAPES OF NUCLEI. Bromley, D. A.; Weneser, J. Comments Nucl. Particle Phys., 2: 55-62(Mar.-Apr. 1968).

The results of some recently published experiments and analyses on the elastic and inelastic scattering of 50-MeV alpha particles by targets in the rare-earth region are reviewed. Angular distributions for scattering by samarium isotopes are considered as an example, and the determination of deformation parameters is stressed. (D.C.W.)

22594 PROTON PAIRING ENERGIES. Banerjee, D. (Palit Lab. of Physics, Calcutta). Nuovo Cim., 54B: 341-3(Apr. 11, 1968).

The dependence of proton pairing energies for even-even nuclei on the nucleon number, the kind of particles that comprise the pair, and the state occupied by the pair was studied. It was found that the proton pairing energies generally increase with increasing J; exceptions were observed for A = 18, 58, 106, 112, 126, 132, and 142 where a decrease of the pairing energy with increasing J was apparent. It was also found that the proton binding energy varies as $A^{-0.5}$, instead of A^{-1} as predicted by Mayer's theory (Phys. Rev., 78: 16(1950). (D.C.W.)

22595 E2 TRANSITION PROBABILITIES IN THE DAVYDOV MODEL. Abecasis, S. M. (IIAE DINFIA, Buenos Aires); Bosch, H. E.; Plastino, A. Nuovo Cim., 54B: 245-52(Apr. 11, 1968).

Ratios of E2-transition probabilities for the de-excitation of levels belonging to the ground-state, beta, and gamma rotational bands in the deformed region 150 < A < 190 are calculated with the Davydov model. A general good agreement with experiment is obtained. (auth)

22596 NUCLEAR DATA SHEETS. Way, Katharine (ed.) (Oak Ridge National Lab., Tenn.). Nucl. Data, Sect. B, 2: B2-4-i-4-120(Dec. 1967).

Nuclear data including energy level and decay schemes are given for nuclei with A = 146, 147, and 148. The "most probable" spin and parity assignments are given for as many levels as possible, and the strongest reasons known for each assignment are indicated. Available mass-difference data are given for these nuclides also. (S.F.L.)

22597 PARTICLE-CORE COUPLING IN THE LEAD NUCLEI. Stein, Nelson; Whitten, C. A. Jr.; Bromley, D. A. (Yale Univ., New Haven). Phys. Rev. Lett., 20: 113-17(Jan. 15, 1968).

Experimental results are presented which indicate the existence, at intermediate energies in the Pb nuclei, of particles in excited states coupled to various excitations of the core. It is shown that the isobaric analogs of these states are selectively excited by proton scattering. The experimental data discussed are proton elastic and inelastic scattering excitation functions from targets of ^{208}Pb and ^{206}Pb. (S.F.L.)

22598 PARITY NONCONSERVATION BY INNER BREMSSTRAHLUNG FROM POLARIZED ^{119}Sb. Brewer, William D.; Shirley, D. A. (Univ. of California, Berkeley). Phys. Rev. Lett., 20: 885-7(Apr. 15, 1968). (UCRL-18087).

The spatial asymmetry of internal bremsstrahlung from ^{119}Sb polarized in Fe at low temperature was observed. The data fit the theoretical correlation function well although some dependence of the asymmetry coefficient A on photon energy was found. At energies near the end point, complete parity nonconservation was observed, in agreement with theoretical predictions. (auth)

22599 MUONIC X RAYS FROM SEPARATED ISOTOPES OF EUROPIUM. Carrigan, R. A. Jr. (Argonne National Lab., Ill.); Gupta, P. D.; Sutton, R. B.; Suzuki, M. N.; Thompson, A. C.; Cote, R. E.; Prestwich, W. V.; Gaigalas, A. K.; Raboy, S. Phys. Rev. Lett., 20: 874-6(Apr. 15, 1968).

Muonic K and L x rays were observed with a Ge(Li) detector for separated isotopes of europium. A modified Fermi charge distribution was used for the analysis of both nuclei. The ^{153}Eu spectrum was fitted by assuming the validity of the rotation model; for the ^{151}Eu, excitation to only the low-lying 21.7-keV state was invoked. The analysis yields values for several level parameters that agree well with the available data. (auth)

22600 DEPENDENCE BETWEEN MASS, VELOCITY, AND ENERGY DISTRIBUTIONS OF FISSION FRAGMENTS. Kashukeev, N. T. (Inst. of Physics, Sofia). Compt. Rend. Acad. Bulg. Sci., 20: 529-32(1967). (In Russian).

The mass, velocity, and energy of corresponding points having the same relative yield satisfy the kinetic energy formula $E = \frac{1}{2} Mv^2$. The conservation of momentum requires that $M_L v_L = M_H v_H$. Here M_L and v_L are the mass and velocity of the light fragment, and M_H and v_H are the mass and velocity of the heavy fragment. The heavy fragment has a smaller velocity than the light fragment for any asymmetrical fission event. If for a given fission event one mass belongs to a light peak and the other to a heavy peak, the same also take place with the velocities. The energy distribution is also analogous. Thus, it is possible to transform one type of distribution into another. It is shown that the fission fragments of ^{252}Cf show a correspondence accurate to 1% between the energies, masses, and velocities of its fission fragments. This correspondence can be used for the absolute energy calibration of semiconductor detectors. (TTT)

22601 INVESTIGATION OF β AND γ RADIATION OF ^{91}Rb. Zherebin, E. A.; Krylov, A. I.; Polikarpov, V. I.; Yuzvuk, N. N. Yadern. Fiz., 7: 3-6(1968). (In Russian).

By means of scintillation spectrometers, β and γ radiations of ^{91}Rb (half-decay period is 1.2 min) were measured. The values of γ-quanta energy and of the β endpoint energy were obtained. (auth)

22602 ON-LINE STUDIES OF MASS-SEPARATED XENON FISSION PRODUCTS. Alvager, T.; Naumann, R. A.; Petry, R. F.; Sidenius, G.; Thomas, T. Darrah (Princeton Univ., N. J.). Phys. Rev., 167: 1105-16(Mar. 20, 1968).

Mass-separated, short-lived Xe fission products from ^{252}Cf were studied using on-line nuclear spectroscopy. The Xe isotopes from a 10-μg Cf source were separated in the Princeton Isotope Separator, and the decay properties of the separated isotopes were measured with a Ge(Li) detector located at the collector of the separator. Results from measurements of the decay of $^{137-142}$Xe and accompanying Cs and Ba isotopes are discussed. (auth)

22603 MEAN KINETIC ENERGY OF THE ^{238}U FRAGMENTS AT THE FISSION BY 6- TO 9-MeV-NEUTRONS. Kuvatov, K. G.; Okolovich, V. N.; Pavlov, A. F. Yadern. Fiz., 7: 39-40(1968). (In Russian).

By means of a double ionization chamber with a control grid, the mean kinetic energy $\bar{E}_k$ of the ^{238}U fragments at the fission by the 6- to 9-MeV neutrons was measured. Within the experimental errors, no change in the $\bar{E}_k$ was observed. On the basis of results of the present work and of the data analysis by the mean number of prompt neutrons, it is assumed that the energy release due to the difference between the mass distributions at low energies and at energies high enough over the threshold is unstable. (auth)

22604 NEUTRON FISSION OF ^{235}U AT THE EXCITATION ENERGY OF COMPOUND NUCLEUS 22 MeV. D'yachenko, P. P.; Kuz'minov, B. D. Yadern. Fiz., 7: 36-8(1968). (In Russian).

Results on the neutron fission of ^{235}U at the excitation energy of the compound nucleus 22 MeV are presented. Variations of the mass and kinetic energy distributions of fragments with the excitation energy of the fissile nucleus are discussed. (auth)

22605 ELECTRIC QUADRUPOLE MOMENTS OF FIRST 2^+ STATES OF EVEN NUCLEI. Davydov, A. S.; Ovcharenko, V. I. (Inst. of Theoretical Physics, Kiev). Yadern. Fiz., 7: 57-64(1968). (In Russian).

Mean values of the electric quadrupole moment of the first 2^+ state of deformed even-even nuclei are calculated in good agreement with the available experimental data. The relation of these values to the form of the nucleus is discussed. Sum rules are obtained for the mean values of the electric quadrupole moment and the reduced probabilities of the E2 transitions in deformed even-even nuclei. The sum rules are tested and are shown to be valid for real nuclei with a reasonable accuracy. (auth)

22606 ISOMERIC CROSS-SECTION RATIO FOR A SPONTANEOUSLY FISSIONABLE ISOMER ^{242}Am. Yungklaussen, Kh. (Joint Inst. for Nuclear Research, Dubna, USSR). Yadern. Fiz., 7: 83-7(1968). (In Russian).

A method for calculation of the isomeric cross-section ratio is described assuming that the isomeric state is at the bottom of the dip of fission barrier with two-bump shape and that the evaporation of neutrons and the fission are competing processes. It is shown on the basis of these assumptions experimental results for the reaction ^{242}Pu(d,2n)^{242}Am are satisfactorily explained. (auth)

22607 SLOW NEUTRON SPECTROSCOPY. Garnsworthy, R. K.; Broomhall, G. J. (Univ. of Melbourne). At. Energy Aust., 11: 10-17(Jan. 1968).

A neutron time-of-flight facility is described in which a betatron is used as the pulsed neutron source. The electron beam impinges on an internal W target producing γ rays which react in an external natural U target to produce the neutrons. The facility can be used for total, scattering, capture, or fission cross-section measurements. Some results that were obtained for W as a test of the facility are given. (D.C.W.)

22608 REACTOR NEUTRON CROSS SECTIONS FOR SOME (n,γ) REACTIONS. Tilbury, R. S.; Kramer, Henry H. (Union Carbide Corp., Tuxedo, N. Y.). Nucl. Sci. Eng., 31: 545-7(1968).

Reactor thermal-neutron (n,γ) cross sections for the isotopes ^{106}Pd, ^{108}Pd, ^{112}Sn, ^{122}Sn, ^{124}Sn, ^{128}Xe, ^{130}Xe, ^{132}Xe, ^{130}Ba, and ^{196}Hg were measured by irradiating the elements in the form of metals, salts, and gases. Cross sections were determined by activation techniques using a NaI(Tl) crystal coupled to a 400-channel analyzer. Cross section values obtained were in good agreement with those determined recently by others. The agreement with cross sections measured years ago was poor, substantiating the need for further work to provide more accurate cross section data. (S.F.L.)

22609 POLARIZATION OF ^{155}Eu NUCLEI IN METALLIC SAMARIUM. Parfenova, V. P.; Erzinkyan, A. L. (Inst. of Nuclear Physics, Moscow). Z. Eksp. Teor. Fiz., 54: 410-12 (Feb. 1968). (In Russian).

The angular distribution anisotropy was observed of 86.5 keV γ quanta accompanying the decay of polarized ^{155}Eu nuclei ($T_{\frac{1}{2}}$ = 1.8 y) in a metallic samarium matrix at low temperatures in an external magnetic field >10kG. The value $\mu H_{eff} = 9 \pm 4 \times 10^5$ nm · G is obtained for the superfine interaction of the ^{155}Eu nucleus with an effective magnetic field on the nucleus. The sign of the anisotropy indicates that the spin of the 86.5-keV ^{155}Gd excited level is $\frac{5}{2}$. (auth)

22610 INTENSITIES OF PARTIAL RADIATION TRANSITIONS TO THE GROUND AND FIRST EXCITED STATES IN RESONANCES OF THE ISOTOPE ^{155}Gd. Danelyan, L. S.; Efimov, B. V.; Sotnikov, S. K. Z. Eksp. Teor. Fiz., 54: 401-9 (Feb. 1968). (In Russian).

Using a two-crystal scintillation spectrometer, the total intensities of γ transitions to the ground and first excited states were measured in 23 resonances of the ^{155}Gd(n,γ)^{156}Cd reaction. The experimental distribution of intensities is in better agreement with the Porter-Thomas two-component distribution with different average intensities than with the distributions $\nu = 1$ and $\nu = 2$. Analysis of the available data points to the possibility of a correlation between intensities and spins of initial states. (auth)

22611 EFFECT OF THE GEOMETRIC PROPERTIES OF THE ENVIRONMENT OF THE MOESSBAUER NUCLEUS IN POLYCRYSTALS ON THE ANGULAR DISTRIBUTION OF RESONANTLY SCATTERED γ QUANTA. Komissarova, B. A.; Sorokin, A. A. (Inst. of Nuclear Physics, Moscow). Z. Eksp. Teor. Fiz., 54: 424-31(Feb. 1968). (In Russian).

Theoretical angular distributions of the nuclear resonance scattering of gamma rays are considered without energy losses on recoil for separate components of a resolved quadrupole doublet under the assumption of an arbitrary symmetry of the electric field gradient and an arbitrary orientation of the system of crystallographic axes with respect to the main axes of the electric-field gradient and taking into account the anisotropy of the probability for the recoilless absorption (and emission) of γ rays by scatterer nuclei. The registration of scattering radiation by conventional and resonance detectors is considered. The angular distribution of the resonance scattering of ^{119}Sn 23.8-keV γ quanta is measured for one of the components of the quadrupole doublet of the compound $(C_4H_9)_2SnO$ with the aid of the resonance detector. From a comparison of new data and the experimental results of a previous paper, conclusions are made on the characteristics of the local field acting on the Sn nuclei in this compound. (auth)

22612 CURRENT VALUES OF FUNDAMENTAL FISSION PARAMETERS. De Volpi, Alexander. Reactor Fuel-Process. Technol., 10: 271-88(Fall 1967).

A survey of information on the neutron absorption, capture, and fission cross sections of ^{239}Pu, ^{241}Pu, ^{233}U, and ^{235}U and on neutron emission in fission of these isotopes is presented. Some information on neutron yields from spontaneous fission of ^{252}Cf is also included. 118 references. (D.C.W.)

22613 GAMMA-RAY SPECTRA OF FISSION PRODUCTS OBSERVED WITH Li-DRIFTED GERMANIUM DETECTORS. II. Oi, Noboru; Tanabe, Isami; Takayanagi, Sei-ichi; Matsushima, Yasuyoshi (Tokyo Shibaura Electric Co., Ltd.). J. Nucl. Sci. Technol. (Tokyo), 4: 372-7(July 1967).

The γ-ray spectra of short-lived fission products from thermal-neutron irradiation of highly enriched U were observed with an encapsulated Li-drifted Ge γ-ray spectrometer. The spectra at various periods (10 min, 30 min; 1, 2, 5, 10, and 20 hr) after irradiation were measured up to about 1 MeV. The relative activities of fission products at various periods after irradiation (10 min ~ 20 hr) were calculated and used for assigning photopeaks. (auth)

22614 GAMMA-RAY SPECTROMETRIC STUDY OF THE PHOTOACTIVATION PRODUCTS WITH 20-MeV BREMSSTRAHLUNG. Oka, Yoshinaga; Kato, Toyoaki; Nomura, Koichi; Saito, Tatsuya (Tohoku Univ., Sendai). J. Nucl. Sci. Technol. (Tokyo), 4: 346-52(July 1967).

All the elements in the periodic chart from Li to Bi except Tc, Pm, and inert gas elements were irradiated for 1 hr with 20-MeV bremsstrahlung generated from a linear electron accelerator, and the resultant radioactivities induced by the photonuclear reactions on these elements were studied by a method based on γ-ray spectrometry. The (γ,n) reactions were found to be the most prominent in this energy region of bremsstrahlung radiation. With light elements particularly, products of (γ,p) reactions were also found to be appreciable. For most of the elements studied, the γ-ray photopeaks were experimentally determined for essentially important photoactivation products thereof with moderate half-lives. The sensitivity, selectivity, and specificity of the method are discussed from these data. The detection limit obtained is about 0.1 μg. (auth)

22615 AVERAGE CROSS SECTIONS AND RESONANCE INTEGRALS OF ^{242m}Am. Perkins, S. T.; Auchampaugh, G. F.; Hoff, R. W.; Bowman, C. D. (Univ. of California, Livermore). Nucl. Sci. Eng., 32: 131-2(Apr. 1968). (UCRL-70735).

The energy dependence of the neutron fission cross of ^{242m}Am was investigated from 0.02 eV to 6 MeV. The measurements were normalized to a value for the fission cross section of 6600 b at 0.0253 eV. Below 3.7 eV and above 300 ke eV, the cross section was corrected for ^{241}Am in the sample. The data are presented in terms of mean values and resonance integrals over the GAM group structure. The resonance integral above 0.5 eV is 1570 ± 110 b. The data below 3.5 eV were analyzed in terms of a sum-of-single-levels fit. For the six resonances below 3.5 eV, the average fission width is 0.46 eV. (D.C.W.)

22616 REDETERMINATION OF SOME ^{127}I(γ,xn) YIELDS. Jonsson, G. G.; Forkman, B.; Lindgren, K. (Univ. of Lund, Sweden. Lund Inst. of Tech., Sweden). Phys. Lett., 26B: 508-9 (Mar. 18, 1968).

The yields of some (γ,xn) reactions on ^{127}I were redetermined in the energy region 150 to 800 MeV. The (γ,n) yield above 150 MeV is compared to the yield predicted by simple estimates of the nucleon and pion transparencies in the iodine nucleus. (auth)

22617 ENERGY SPECTRUM OF ^{116}Sn AND EFFECTIVE NUCLEAR FORCES DERIVED FROM THE REALISTIC NUCLEON–NUCLEON POTENTIALS OF YALE AND OF TABAKIN. Gmitro, M.; Sawicki, J. (International Centre for Theoretical Physics, Trieste, Italy). Phys. Lett., 26B: 493-6(Mar. 18, 1968).

The effective nuclear forces are obtained by the core polarization renormalization from a realistic local static (Yale) and from a nonlocal (Tabakin) nucleon-nucleon potential. These forces are applied to the quasiparticle Tamm-Dancoff theory of the spectrum of ^{116}Sn. While the respective bare (unrenormalized) forces lead to different predictions, the renormalized Yale and Tabakin effective forces yield almost identical results. While the second-order core polarization corrections are quite large, the successive inclusion of all the higher-order corrections (iteration) leads to only negligible modifications. (auth)

22618 THE ^{140}Ba YIELDS FOR THERMAL AND FAST FISSION OF ^{235}U AND ^{238}U. Ciuffolotti, L. (SORIN, Saluggia, Italy). Energ. Nucl. (Milan), 15: 272-6(Apr. 1968).

The absolute and relative yields of ^{140}Ba were measured for fission of ^{235}U and ^{238}U by thermal and fast neutrons respectively, in order to obtain a more reliable value for the fast fission yield than available at present. The facilities of the L-54 reactor of CESNEF (Milano) were used for irradiating a small ionization chamber containing the uranium samples and the fission rate monitors. By means of direct spectrometry of the γ-ray activity of ^{140}La at equilibrium with its parent ^{140}Ba, yield values can be deduced with a good degree of accuracy. (auth)

Nuclear Theory

Refer also to abstracts 22329, 22410, 22542–22544, 22547, 22548, 22552, 22558, 22560, 22561, 22563, 22568, 22574, 22576, 22579, 22583, 22587, 22590, 22595, 22600, 22605, 22606, 22611, and 22617.

22619 (AECL-3041) NUMERICAL CALCULATION OF NUCLEAR SLATER INTEGRALS. Nachamkin, J. (Atomic Energy of Canada Ltd., Ottawa (Ontario)). Mar. 1968. 11p. Dep. CFSTI. CAN $0.50.

A simple method is used to reduce the domain of integrations needed for the evaluation of Slater integrals. In effect, the two-dimensional integrals over a large square are reduced to quadra-

ture on a narrow strip along a diagonal of the square for the most common local two-body forces. The time saved using this method is quite considerable for short-ranged potentials. Using an unrealistically short-ranged Gaussian two-body potential an accuracy of 3% or better was obtained in every case. (auth)

22620 (ISS-67/23) INTRODUZIONE ALLA FISICA DELLE RADIAZIONI. CAPITOLO VI. IL NUCLEO ATOMICO E LA RADIOATTIVITA. (Introduction to Radiation Physics. Chapter VI. Atomic Nuclei and Radioactivity). Amaldi, U. Jr. (Istituto Superiore di Sanita, Rome (Italy). Laboratori di Fisica). Sept. 5, 1967. 88p. (In Italian). Dep.

This is the sixth of the series of reports on the lectures on Radiation Physics held at the Scuola di Specializzazione in Radiologia Medica dell'Università di Roma. This issue is devoted to nuclear structure; to α, β, and γ radioactivity; and to the laws determining the time behavior of the activity of a radioactive sample. The last two sections contain the definition of cross section and a short description of the methods by which artificial isotopes are produced. (auth)

22621 (SLAC-79) FADDEEV'S EQUATIONS FOR LOCAL POTENTIALS. Osborn, Thomas Arthur (Stanford Linear Accelerator Center, Calif.). Dec. 1967. Contract AT(04-3)-515. 129p. Dep. CFSTI.

Thesis.

Solutions of Faddeev's equations for an arbitrary potential are derived and are used to test the validity of the assumption that two-body potentials can be represented as separable potentials. The equations for the three-body problem are simplified; the number of independent variables is reduced from six to two by expanding the system in terms of a complete set of angular momentum wave functions. A two-variable integral equation is thereby obtained, and numerical techniques are developed with which this integral equation can be represented as a finite matrix problem. Binding energies and wave functions for a system of three identical particles are obtained using nonseparable exponential and Yukawa potentials. The system manifests a number of three-body bound states depending on the strength of the two-body attraction. The bound-state wave functions are described. It is found that the separable approximation is useful only in the limit in which the two-body forces are weak. (D.C.W.)

22622 SOME APPROXIMATIONS IN THE THEORY OF NUCLEAR MATTER. Weigel, M. (Univ., Munich). Nuovo Cim., 54B: 326-31(Apr. 11, 1968).

The system of equations for the nuclear-matter problem including two-particle correlations is derived without using thermodynamic Green functions. A number of approximations are considered. (D.C.W.)

22623 ON THE MEASUREMENT OF β-RADIATION HELICITY. Braicovich, L. (Istituto di Fisica del Politecnico, Milan. CNR, Milan). Nuovo Cim., 54B: 346-8(Apr. 11, 1968).

A method for measuring the helicity of β particles is outlined. The method can be used to measure the helicity vs energy of a continuous β spectrum up to the endpoint if a calibration of the instrument within a limited energy range is made on the basis of the known values of the helicity of ^{32}P β rays. (D.C.W.)

22624 LITERAL TRUTH OF THE SHELL MODEL: SINGLE NUCLEONS. Wilkinson, Denys H. Comments Nucl. Particle Phys., 2: 48-54(Mar.-Apr. 1968).

The testing of the shell-model formalism for nuclear wave functions by knockout reactions is briefly discussed. The theoretical bases of this approach are summarized together with some typical experimental results. Some data on the $^{12}C(e,ep)^{11}B$ reaction are shown to support the shell-model prescription, at least for light nuclei. (D.C.W.)

22625 DIFFRACTIONAL GENERATION OF PIONS BY THE 24 GeV/c PROTONS ON COMPLEX NUCLEI OF EMULSION. Abduzhamilov, Sh.; Azimov, S. A.; Chudakov, V. M. (Inst. of Physics, Tbilisi, USSR). Yadern. Fiz., 7: 95-9(1968). (In Russian).

Comparing angular distributions in clear and unclear stars with the number of secondary particles $n_s = 3$ and $n_s = 4$, one has an indication to the presence of the reaction $P + A \rightarrow A + N + n\pi$ in the set of clear three-prong events. The mean cross section of the reaction on complex nuclei of the emulsion is 4.8 ± 1.2 mbarn. By means of dispersion analysis, it is found that there is no uniformity in the set of clear three-prong events, due to different mechanisms of their production. (auth)

22626 REACTIONS WITH REARRANGEMENT. Efimenko, T. G.; Zhigunov, V. P.; Zakhar'ev, B. N. (Joint Inst. for Nuclear Research, Dubna, USSR). Yadern. Fiz., 7: 76-82(1968). (In Russian).

A method is presented to describe scattering processes accompanied by a rearrangement of particles in framework of the unified theory of nuclear reactions. The problem is reduced to solution of a set of inhomogeneous differential equations and a set of simple algebraic equations. The given method makes it possible to account the Pauli principle for scattered particles and to describe the reactions with more than two fragments. The work is an essential modification of the method of truncated asymptotics. (auth)

22627 SHELL MODEL AND A PARTICULAR CASE OF THE THREE-BODY PROBLEM. Zhmailo, V. A. Yadern. Fiz., 7: 68-73(1968). (In Russian).

The accuracy of some approximations used in the shell model (the method of mixed configurations, the oscillator potential) and the accuracy of data on the nucleon interactions in nuclei, obtained with these approximations, are elucidated with a simple model as an example and by means of the method presented in (Nucl. Phys., 82: 129(1966)). It is shown that in the zero-range approximation the neutron interaction in a nucleus has the scattering length $a_s = 0.5$ f. (auth)

22628 d- AND α-ASSOCIATING IN HEAVY NUCLEI. Cherdantsev, P. A.; Rodimova, O. B. Yadern. Fiz., 7: 65-7(1968). (In Russian).

The d- and α-associating in the systems consisting of a large number of particles with equal numbers of protons and neutrons was studied. It was shown that the associating effect holds at small densities and takes the maximum value near the surface of a system. α associations are produced at higher densities than d associations. As the density increases the associating effect gradually disappears. (auth)

22629 KINEMATIC CHARACTERISTICS OF RESIDUAL NUCLEI IN CASCADE PROCESS AT 660 MeV PROTON ENERGY. Kochkin, V. I.; Lozhkin, O. V.; Mal'tseva, N. S.; Mal'tsev, V. M.; Yakovlev, Yu. P. (Joint Inst. for Nuclear Research, Dubna, USSR). Yadern. Fiz., 7: 31-5(1968). (In Russian).

Calculations of the kinematics and energy distribution of excited nuclei remaining after the cascade process are given. The results of the calculation are compared with experimental data. (auth)

22630 PROBABILITIES OF SINGLE-PARTICLE RADIATIVE TRANSITIONS IN A MODEL WITH ANISOTROPIC SAXON-WOODS POTENTIAL. Begzhanov, R. B.; Belen'kii, V. M.; Safarov, R. Kh. (Inst. of Nuclear Physics, Tashkent). Izv. Akad. Nauk Uzb. SSR, Ser. Fiz.-Mat. Nauk, No. 6, 40-5(1967). (In Russian).

The delay factors $F = \beta_{theor}(\lambda)/\beta_{exp}(\lambda)$ calculated using the Nilsson model N_{Nil} were compared with the F_{S-V} model based on the Saxon-Woods model (using tabulated data for ^{181}Ta, ^{179}Ta, ^{177}Lu, ^{175}La, ^{177}Hf, and ^{179}Hf). It is known that E1 transitions with $\Delta K = 1$ have the F_{Nil} delay $\sim 10^2$ to 10^3. According to the calculations, the F_{S-W} delay is only 2 to 3 nuclei less than the Nilsson's factors. Consequently, calculations using the model of Saxon-Woods anisotropic potential are in better agreement with the experimental data for delayed E1 transitions and for the accelerated γ transitions. (R.V.J.)

22631 COMPARISON WITH THEORY OF EXPERIMENTAL VALUES OF L/K ORBITAL ELECTRON CAPTURE RATIOS FOR ALLOWED AND FIRST-FORBIDDEN TRANSITIONS. Fink, R. W. (Georgia Inst. of Tech., Atlanta). Nucl. Phys., A110: 379-84(1968).

Precision values of L/K orbital electron capture ratios available up to October 1967, are compared with recent theoretical calculations, both with and without correction for electron exchange. In the region between $13 \leq Z \leq 37$, a comparison of experimental values of the exchange correction factor is made with theoretical values calculated by Bahcall. The results show that the experimental values for the L/K capture ratios fall somewhat below the theoretical predictions even with correction for electron exchange. This conclusion is consistent with the results for M/L orbital electron capture ratios, where the disagreement between theory and experiment is larger than that for the L/K capture ratios. (auth)

22632 TEST ON THE SU_4 SYMMETRY OF NUCLEI. Burdet, G.; Maguin, C.; Partensky, A. (Faculte des Sciences, Lyon). Nuovo Cim., 54B: 1-10(Mar. 11, 1968). (In French).

The Wigner supermultiplet theory is considered taking into account all the invariant operators of SU_4. It is shown that a relation coming from the mass formula of the model is satisfied within an error of 5% for isobaric supermultiplets from A = 40 to 254. (auth)

22633 EFFECTIVE INTERACTION AND EFFECTIVE CHARGE FOR VALENCE NUCLEONS IN COLLECTIVE VIBRATION AND CORE POLARIZATION. Bando, Hiroharu (Kyoto Univ.). Progr. Theor. Phys. (Kyoto), 38: 1285-96(Dec. 1967).

It is necessary to investigate the reality or origin of the "pairing plus Q-Q force" in order to study the mechanism of the collective motions in medium and heavy nuclei. The effective interaction and the effective charge renormalized by the core polarization are calculated from the reaction matrix derived from the nuclear force. The adiabatic approximations are made between the collective oscillation and two-particle ladder scattering and also between the oscillation of the core and that of the valence nucleons. Calculations are made exactly without using the perturbation expansion. The core polarization enhances the particle-hole interactions for J = 2, 4, and 6 remarkably and almost unchanges those for J = 1, 3, and 5. The resulting renormalized effective interaction has properties somewhat advantageous to the collective enhancement. The J = 2 particle-hole interaction becomes, however, much larger than the usual Q-Q force, while the J = 0 particle-particle interaction is not much larger than the usual pairing interaction. The calculated effective charge is rather too small. Thus the results do not agree with the physical picture with the usual "pairing plus Q-Q force." (auth)

22634 NOTE ON THE PEAK-COUNTING METHOD IN EXCITATION FUNCTIONS. Roeders, J. D. A. (Univ. of Groningen, Netherlands). Nuovo Cim., 54B: 151-5(Mar. 11, 1968).

Some results on the method of peak counting, which were obtained analytically by Bizzeti and Maurenzig (Nuovo Cim., B47: 29(1967)), are compared with results of calculations that used synthetic excitation functions (Nucl. Phys., B80: 14(1966)). It is concluded that both methods of calculation are equally useful in deriving results on the method of peak counting in excitation functions. (D.C.W.)

22635 TWO- AND FOUR-QUASIPARTICLE TAMM-DANCOFF THEORIES OF VIBRATIONAL STATES OF MEDIUM-HEAVY NUCLEI WITH UNFILLED SHELLS OF BOTH NEUTRONS AND PROTONS. I. GENERAL THEORY. Hendekovic, J. (International Centre for Theoretical Physics, Trieste, Italy); Sawicki, J.; Ottaviani, P. L.; Savoia, M. Nuovo Cim., 54B: 80-100(Mar. 11, 1968).

The quasi particle second Tamm-Dancoff (QSTD) microscopic theory described in previous publications is extended to include two- and four-proton quasi particle (qp) and mixed two-proton two-neutron qp excitations. The formalism is appropriate to describe spectra of vibrational spherical nuclei with unfilled shells of both neutrons and protons. Variants of this theory are described in which the microscopic two-qp QTD phonons are employed in the construction of the basis of a modified QSTD Hilbert space. Formulas are given for the electromagnetic moments and transition matrix elements of the nuclear states. Current numerical applications to the analysis of the spectra of ^{114}Cd and of the even Ge isotopes are discussed. (auth)

22636 CHARGE DISTRIBUTION IN NUCLEI. Bethe, H. A. (Cornell Univ., Ithaca, N. Y.); Elton, L. R. B. Phys. Rev. Lett., 20: 745-7(Apr. 1, 1968).

Some formulations for the charge distribution in nuclei were studied, including a distribution with a Wine-bottle shape. It was found that multiplication of Fermi-type and differential Thomas-Fermi distributions by a wine-bottle factor gave radial distributions which fit electron scattering data and muonic x-ray spectral data. A distribution that was calculated using single-particle wave functions gave agreement with the electron scattering data, but not with the x-ray data. (D.C.W.)

22637 THE LOW-LYING ENERGY LEVELS OF ^{18}O NUCLEUS. Narayana, K. L. (Shivaji Univ., Kolhapur, India). Curr. Sci. (India), 37: 132-3(Mar. 5, 1968).

A new shell-model assignment of energy levels and spacings for ^{18}O is presented. Calculations were used in which the ^{18}O nucleus was considered on the basis of the intermediate-coupling individual-particle model as consisting of a doubly magic core plus two extra neutrons in a (2S-1d) shell. A modified Gaussian-type interaction was used for the radial part of the two-body interaction between the extra-core neutrons. The single-particle level spacings between $d_{\frac{5}{2}}-d_{\frac{3}{2}}$ and $d_{\frac{5}{2}}-s_{\frac{1}{2}}$ were first taken to be the same as that observed in the ^{17}O nucleus. Several exchange mixtures were used, and a study of the T = 1 level spacings, with the lowest 0^+ level as the ground state of the ^{18}O nucleus, was made with a variable strength parameter of the two-body potential. (S.F.L.)

22638 NUCLEAR QUADRUPOLE OSCILLATIONS DUE TO THE COLLECTIVE MOTION OF ALL PROTONS RELATIVE TO ALL NEUTRONS. Nakajima, Akira; Suzuki, Ryoji (Tokyo Coll. of Science). Genshikaku Kenkyu, 12: 355-63(Dec. 1967). (In Japanese).

It is shown that the quadrupole giant oscillations are due to the collective motions of two irrotational fluids consisting of protons and neutrons inside the incompressible nucleus. The resonance energy of quadrupole giant oscillation is calculated for ^{166}Er; the results are approximately in agreement with the experimental results. (NSA of Japan)

22639 INELASTIC PROTON SCATTERING AND THE DEFORMED SPIN-DEPENDENT OPTICAL POTENTIAL. Sherif, H.; Blair, J. S. (Univ. of Washington, Seattle). Contract AT(45-1)-1388. Phys. Lett., 26B: 489-92(Mar. 18, 1968). (RLO-1388-52).

Inelastic proton asymmetries and spin-flip probabilities, as well as cross sections, are calculated in the DWBA approximation with a deformed spin-dependent potential of the full Thomas form. Consideration of the full term improves substantially the fit to observed asymmetries when $E_p \geq 29$ MeV. (auth)

22640 NEUTRON TUNNELING REACTIONS. May, R. M. (California Inst. of Tech., Pasadena). Phys. Lett., 26B: 482-3(Mar. 18, 1968).

Limiting forms of Buttle and Goldfarb's neutron tunneling amplitude are used to obtain a simple analytic expression for the correction to Breit et al.'s formula for reactions with Q = 0, and the analogy of Breit's result when $Q \neq 0$. (auth)

22641 GENERATOR-COORDINATE METHOD AND THE RANDOM PHASE APPROXIMATION. Brink, D. M.; Weiguny, A. (Oxford Univ.). Phys. Lett., 26B: 497-500(Mar. 18, 1968).

The equations of generator coordinate method in the Gaussian overlap approximation are solved in a way which suggests a relation with the random phase approximation. (auth)

22642 j-DEPENDENCE FOR 2p NEUTRON TRANSFER IN (d,p) REACTIONS. Robson, B. A. (Australian National Univ., Canberra). Phys. Lett., 26B: 501-2(Mar. 18, 1968).

The marked j-dependence observed for 2p neutron transfer in (d,p) reactions at about 10-MeV bombarding energy is described by the distorted-wave theory. (auth)

22643 VILLARS FORMALISM FOR NUCLEAR ROTATION. Peierls, R. E.; Urbano, J. N. (Oxford Univ.). J. Phys., A, 1: 1-10(Jan. 1968).

The method proposed by Villars for describing the rotational states of nuclei is discussed. For simplicity only two-dimensional rotation is considered for the ground-state band of an even-even nucleus in which the last occupied sub-shell of the deformed potential is completely filled. It is shown how to avoid inconsistencies arising from the multi-valuedness of the angle variable which appears in the formalism. In the Villars method the moment of inertia appears in terms of a sum over the eigenstates of the "intrinsic" Hamiltonian. Since these are not calculable exactly, an approximation scheme is required. A possible scheme based on the Hartree-Fock approximation is used, though for the present this is approximated further by the use of harmonic oscillator wave functions. The case of ^{28}Si is treated by way of illustration. The detailed model is too unrealistic to expect physically significant results; it does suggest, however, that the method is suitable for practical evaluation. Further steps for improving the accuracy are discussed. (auth) (UK)

22644 STATISTICAL INTERFERENCE EFFECTS IN SEQUENTIAL DECAYS OF THE COMPOUND NUCLEUS. Gadioli-Erba, E.; Sona, P. G. (CISE, Milan. Univ., Milan). Energ. Nucl. (Milan), 15: 261-3(Apr. 1968).

The statistical interference effects of sequential decays of the compound nucleus are discussed. It is shown that under certain conditions, and for experiments with good energy resolution of the emitted particles, they can give rise to fluctuations of a cross section two or more times faster than the usual ones. (auth)

22645 RECENT RESULTS ON ELECTRON CAPTURE. Berenyi, D. (Inst. of Nuclear Research, Debrecen, Hungary). Rev. Mod. Phys., 40: 390-8(Apr. 1968).

A survey on the new theoretical and experimental results in the field of electron-capture processes is given. (auth)

22646 EXPLANATION OF THE MASS ASYMMETRY IN NUCLEAR FISSION. Kelson, I. (Yale Univ., New Haven). Phys. Rev. Lett., 20: 867-71(Apr. 15, 1968).

The asymmetric mass yield distribution in spontaneous fission is simply related to the intrinsic nuclear structure and to the nuclear spin-orbit coupling. (auth)

22647 RAYLEIGH SCATTERING OF POLARIZED PHOTONS. Somayajulu, D. R. S.; Lakshminarayana, V. (Andhra Univ., Waltair, India). J. Phys., A, 1: 228-35(Mar. 1968).

Partially polarized photons of energies 0.56 and 0.78 mc^2 were produced by Compton scattering in aluminium of gamma rays from a 10.8 Ci ^{137}Cs source. They were used to study the Rayleigh scattering cross sections in two orthogonal planes, and the asymmetry ratios were determined at Rayleigh scattering angles of 45, 60, 75, 90, and 105° in each case. The data in the two planes were simultaneously collected by using two scintillation counters. The theoretical values of the asymmetry ratios were estimated and compared with the experimental results. In all cases the experimental results were found to be in satisfactory agreement with the theory of Brown and Mayers. (auth) (UK)

22648 ADVANCES IN NUCLEAR PHYSICS. VOLUME I. Baranger, Michel; Vogt, Erich (eds.). New York, Plenum Press, 1968. 429p. $18.50.

A series of five review papers is presented on current major topics in nuclear physics research, with emphasis on the physical aspects rather than on theoretical treatment or experimental techniques. Review chapters are given on: the reorientation effect, nuclear SU_3 model, Hartree–Fock theory of deformed light nuclei, statistical theory of nuclear reactions, and nonrelativistic three-particle scattering theory. (S.F.L.)

For abstracts of individual papers see: 22415 and 22649–22652.

22649 REORIENTATION EFFECT. de Boer, Jorrit (Rutgers-The State Univ., New Brunswick, N. J.); Eichler, Joerg. Advan. Nucl. Phys., 1: 1-65(1968).

The reorientation effect in Coulomb excitation is discussed as a tool to measure static quadrupole moments in excited nuclear states. Since the electromagnetic field produced in a Coulomb excitation is well known, the method is free from the ambiguities inherent in methods employing the fields produced by the atomic electrons. In order to furnish a basis for the interpretation of experiments an outline of the theory is given in the framework of a perturbation expansion. Even if the assumptions underlying the perturbation approach are not strictly satisfied, the explicit nature of its solutions provides an indispensable guide for designing an experiment. For the actual evaluation one has to utilize the numerical solution obtained from a direct treatment of the time-dependent Schrödinger equation. Some care is devoted to the discussion of other effects which might contribute to the excitation and thus affect the measurement of the quadrupole moment. Both magnetic dipole reorientation and excitation via the giant dipole resonance turn out to be innocuous within present experimental accuracies. Various possible experiments and experimental techniques are treated in some detail, and the results obtained so far are presented and discussed. The appendix aims to facilitate the planning of experiments by compiling numerical formulas, tables, and graphs. (auth)

22650 THE NUCLEAR SU_3 MODEL. Harvey, M. (Chalk River Nuclear Lab., Ontario). Advan. Nucl. Phys., 1: 67-182 (1968).

A review is given of the nuclear SU_3 model. Discussions are given on: the basic shell model; the groups U_3 and SU_3; symmetry of oscillator quanta; the effective interaction; application of the SU_3–coupling scheme to light nuclei; the harmonic oscillator; use of groups in quantum mechanics; the symmetric and unitary groups; generating operators of U_3; classification according to SU_3 without the harmonic oscillator; raising and lowering operators of the group SU_3; calculation of matrix elements; the normalization coefficients and overlaps; and the use of the group SU_3 in the classification of elementary particles. (S.F.L.)

22651 THE HARTREE–FOCK THEORY OF DEFORMED LIGHT NUCLEI. Ripka, Georges (CEN, Saclay, France). Advan. Nucl. Phys., 1: 183-259(1968).

The calculation and study of deformations in light-weight nuclei with the Hartree–Fock (H. F.) method are reviewed. The article is an attempt to illustrate most of the important results of the H. F. calculations for light nuclei and also to show the limitations of the method. Topics discussed are: the equations; symmetries of the H. F. Hamiltonian; the choice of an expansion for the orbits; single major shell H. F. calculations; deformed excited equilibrium states of spherical nuclei; the effect of the exchange components of the interaction; the quadrupole–quadrupole interaction; the effect of spin–orbit splitting; the multiplicity of H. F. solutions; magnetic moments of odd-A nuclei; angular momentum projection; and major-shell-mixing calculations. (S.F.L.)

22652 STATISTICAL THEORY OF NUCLEAR REACTIONS. Vogt, Erich (Univ. of British Columbia, Vancouver). Advan. Nucl. Phys., 1: 261-342(1968).

The statistical theory of nuclear reactions is reviewed with emphasis on the use of the evaporation model rather than on its foundation in theory. Discussions are included on: early evaporation models and their refinement; basic evaporation theory; extension of the model to differential cross sections; behavior of transmission functions; applications to neutron inelastic scattering at low energies and to $^{12}C + ^{12}C$ reactions; evaporation model with level densities; the range of recent applications; and basis of the evaporation model in reaction theory. (S.F.L.)

REACTOR TECHNOLOGY

Central Power Reactors

Refer also to abstracts 21088, 21369, 21371, 21699, 21728, 21752, and 21776.

22653 (ANL-7419) REACTOR DEVELOPMENT PROGRAM. Progress Report, January 1968. (Argonne National Lab., Ill.). Feb. 27, 1968. Contract W-31-109-eng-38. 158p. Dep. CFSTI.

REACTORS, LIQUID METAL-COOLED—fuels for, radiation testing of

REACTOR FUELS—technetium determination in irradiated uranium-plutonium-zirconium; swelling of EBR-2, effect of enrichment on; burnup analysis of, by x-ray spectrometric determination of rare earth fission products; radiation testing of ceramic, in MTR; thermal diffusivity or uranium carbide (UC) and plutonium carbide (PuC)

REACTOR FUEL ELEMENTS—jacket-alloys for, sodium corrosion of; dimensional changes in irradiated EBR-2 driver subassemblies; temperatures of subassemblies at 50 and 62.5 MW(t) in EBR-2, (T); cladding-coolant interactions in meltdown accidents

CRITICAL ASSEMBLIES—core for FTR mockup in ZPR-3, composition of; control rods for FTR mockup in ZPR-3, calibration of; core for ZPR-6, composition of multiregion; reactivity effect in ZPR-9, effects of sample environment on uranium-238 Doppler

SODIUM—impurities in, in-line oxygen meter for determining; quality control of, steam-reaction method for; corrosine effects on Type-304 stainless steel pipe at 1200°F; effects of liquid, on wear properties of materials; effects of vapor, on electrical resistance of Durock insulation; analysis of EBR-2 coolant, for trace-metal impurities; corrosive effects on vanadium at 700°C; carbon transport in; combustion of sprayed, in air, analysis of temperature and burning rate from, (T)

STAINLESS STEELS—corrosion of Type-304, by 1200°F sodium

ELECTRIC INSULATORS—resistance of Durock, effect of sodium vapor on

EXPERIMENTAL BREEDER REACTOR-II—fuel subassemblies from, dimensional changes in irradiated driver; reactivity feedback at 22.5 MW(t) in, description of, (E/T); reactivity power coefficient behavior during operation of, (E/T); control-rod thimble deformation in; coolant flow rates through driver-fuel subassemblies at 800°F, (T); fuel subassembly temperatures at 50 MW(t) and 62.5 MW(t) in, (T); fuel swelling in, effect of enrichment on; reactivity variations from fuel and reflector subassembly movements in; coolant quality monitoring and control; fuel cycle facility operations during Jan. 1968

URANIUM ALLOYS AND SYSTEMS—fissium-U, pressure, heat treatment, and burnup effects on swelling of

FISSIUM—fissium-U, pressure, heat treatment, and burnup effects on swelling of

REACTORS—excursions in, coherence effects in super prompt critical, (T); neutron flux synthesis in, variational method for, (T); core deformation under inpulsive loading, analysis of cylindrical, (T)

NEUTRONS—flux synthesis in reactors, variational method for, (T)

FISSION PRODUCTS—determination of rare earth, in fast reactor fuels, x-ray spectrometric

URANIUM ISOTOPES-U-238—fission by 5.6 MeV neutrons, mass-energy-angle correlation for

VANADIUM—neutron cross sections of, differential elastic-scattering and total; corrosion by 700°C sodium, effects on nitrogen and oxygen concentration of

NEUTRONS, FAST—reactions (n,f) with uranium-238 at 5.6 MeV, mass-energy-angle correlations for

NITROGEN—concentration in vanadium exposed to 700°C sodium

OXYGEN—concentration in vanadium exposed to 700°C sodium

MAGNESIUM—reaction with sodium-filled nickel capsule at 650°C

NICKEL—reaction with magnesium in sodium solution at 650°C

PLUTONIUM CARBIDES—thermal diffusivity of, (E); PuC-UC, thermal diffusivity of, (E)

URANIUM CARBIDES—thermal diffusivity of, (E); PuC-UC, thermal diffusivity of, (E)

WATER—boiling detection in, acoustic resonance frequency analysis for, (E/T)

MAGNESIUM CHLORIDES—$MgCl_2$-MgF_2, phase diagram for; KCl-$MgCl_2$-MgF_2-NaCl, phase disengagement studies on entrainment of metals in; KCl-$MgCl_2$-NaCl, phase disengagement studies on entrainment of metals in

MAGNESIUM FLUORIDES—$MgCl_2$-MgF_2, phase diagram for; KCl-$MgCl_2$-MgF_2-NaCl, phase disengagement studies on entrainment of metals in

MAGNESIUM ALLOYS AND SYSTEMS—Cu-Mg, phase disengagement studies on entrainment of, in ternary salts; Cd-Mg, phase disengagement studies on entrainment of, in ternary salts; Mg-Zn, phase disengagement studies on entrainment of, in ternary salts

POTASSIUM CHLORIDES—KCl-$MgCl_2$-MgF_2-NaCl, phase disengagement studies on entrainment of metals in; KCl-$MgCl_2$-NaCl, phase disengagement studies on entrainment of metals in

SODIUM CHLORIDES—KCl-$MgCl_2$-MgF_2-NaCl, phase disengagement studies on entrainment of metals in; KCl-$MgCl_2$-NaCl, phase disengagement studies on entrainment of metals in

CHROMIUM—solubility in zinc at 400 to 800°C

ZINC—solvent properties for chromium at 400 to 800°C

CARBON—transport in sodium

PLUTONIUM ALLOYS AND SYSTEMS—O-Pu, sublimation of vapor phases in, partial heats of

OXYGEN SYSTEMS—O-Pu, sublimation of vapor phases in, partial heats of

COPPER ALLOYS AND SYSTEMS—Cu-Mg, phase disengagement studies on entrainment of, in ternary salts

CADIUM ALLOYS AND SYSTEMS—Cd-Mg, phase disengagement studies on entrainment of, in ternary salts

ZINC ALLOYS AND SYSTEMS—Mg-Zn, phase disengagement studies on entrainment of, in ternary salts

CALCIUM CHLORIDES—$CaCl_2$-CaF_2, phase disengagement studies on entrainment of metals in

REACTOR, CONTROL ELEMENTS—thimble deformation on EBR-2

CALCIUM FLUORIDES—$CaCl_2$-CaF_2, phase disengagement studies on entrainment of metals in

ARGONNE ADVANCED RESEARCH REACTOR—core structures for, heat transfer analysis of, (T); seismic stress limit criteria for

REACTOR SAFETY EXPERIMENTS—converter-system design for fast fuel cluster testing in TREAT

TIN—fragmentation of molten, when dropped into water

AIR—reactions with sprayed sodium, temperature and burning rate from, (T)

REACTOR SAFETY—core loading analysis for, plastic deformation of cylindrical shells in, (T) (H.D.R.)

22654 (APDA-220) A PROPOSED PROGRAM FOR THE DESIGN AND DEMONSTRATION OF A PROTOTYPE UNDER-SODIUM ULTRASONIC SCANNER. Matte III, J. (Atomic Power Development Associates, Inc., Detroit, Mich.). Feb. 1968. Contract AT(11-1)-865. 41p. Dep. CFSTI.

The applicability to large Na-cooled reactors of the under-sodium ultrasonic transducer is shown to depend on the development of mechanisms suitable for accurate and versatile manipulation of the transducer within the reactor. A program of prototype design and testing is proposed to demonstrate the feasibility and desirability of such a device for eight typical applications to such reactors. The functional requirements of a prototype scanner and of a suitable demonstration test rig are presented, together with brief descriptions of initial concepts of the prototype and the test rig. The proposed program of demonstration tests is outlined, together with the basis for evaluating the prototype performance in each application. (auth)

22655 (AWRE-R-5/65) A MODEL INVESTIGATION OF EXPLOSIVE CONTAINMENT IN SINGLE TANK FAST REACTORS. Rees, N. J. M. (Atomic Weapons Research Establishment, Aldermaston (England)). Nov. 1965, Reprinted June 1966. 44p. (CONF-651009-1). Dep. CFSTI, UK.

Experiments were performed using chemical explosives to simulate on a model scale the rapid release of energy in the core of a fast reactor under maximum accident conditions. The shock pressure loading on the core plug, walls and roof were measured using 12 piezo-electric pressure gauges. Water was used to simulate the coolant in the reactor tank. The pressure loadings on the walls of the main tank clearly showed the direct shock wave, the reflected shock from the base of the tank and the reflected rarefaction from the water surface. The pressure loading on the

roof was due to the impact of water thrown upwards when the direct shock was reflected at the surface. The impact pressure loading on the roof appears to be reflected and a pulse was propagated back down through the contents of the vessel. The loose core access plug was ejected from the thick walled vessels. The lower velocities were observed when premature failure of a vessel occurred and the highest when the vessel was full of water. For a 1.1 in. air gap between the water surface and the roof, the presence of the model reactor structure surrounding the charge seemed to have little effect on the plug ejection velocity. Premature failure of the overstrong main tank reduced the plug energy; this was confirmed by firings in models with a weak main tank. (auth)

22656 (BMI-1832) ECCSA-I: A DIGITAL COMPUTER PROGRAM FOR THERMAL AND HYDRAULIC ANALYSIS OF CORE CHANNELS IN THE EVENT OF A NUCLEAR-REACTOR LOSS-OF-COOLANT ACCIDENT. Iyer, Jay S. (Battelle Memorial Inst., Columbus, Ohio). Apr. 1, 1968. Contract W-7405-eng-92. 79p. Dep. CFSTI.

ECCSA-I is a digital computer program specifically designed to predict the thermal and hydraulic performance of reactor core channels during a loss-of-coolant accident and subsequent emergency core cooling injection. The program represents reactor fuel rods and associated flow channels by means of an equivalent single channel. Thermal and hydraulic behavior in the channel is predicted on a local basis at various axial positions during the blowdown, core heat-up, and emergency core cooling injection phases of an accident. Blowdown pressure and flow information are used as input data for ECCSA-I. The development and content of the program is described, including major assumptions, mathematical models, and computer equations. A source deck and sample problem for the CDC-6400 computer will be available through the ANL Code Center. Typical results are presented for analyses of BWR, PWR, and LOFT loss-of-coolant accidents. (auth)

22657 (BMI-X-10222) FISSION-PRODUCT DEPOSITION AND ITS ENHANCEMENT UNDER REACTOR ACCIDENT CONDITIONS. Quarterly Progress Report, October–December 1967. Genco, Joseph M.; Rosenberg, Harvey S.; Berry, David A.; Berry, Warren E.; Cremeans, George E.; Morrison, David L. (Battelle Memorial Inst., Columbus, Ohio). Jan. 1, 1968. Contract W-7405-eng-92. 42p. (EURAEC-1994). Dep. CFSTI.

Work performed under United States–Euratom Joint Research and Development Program.

Results of measurements of hydrogen iodide (HI) deposition on stainless steels are shown graphically; data are tabulated. Effects of geometry on deposit-surfaces are considered. Effects of pressure and temperature on elemental iodine deposition on painted surfaces are determined; data are tabulated according to surface. Liquid-phase deposition of iodine and tellurium ions under containment systems conditions is measured. Deposition data are applied to postulated reactor accidents. Effects of use of containment spray systems on containment system coatings are analyzed. Data are presented on adhesives for bonding asbestos to steel. 9 references. (M.L.S.)

22658 (BNWL-475) SHORT-TERM DYNAMIC EFFECTS ON THE UTILIZATION OF PLUTONIUM AS A REACTOR FUEL. Sheff, James R. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). July 1967. Contract AT(45-1)-1830. 53p. Dep. CFSTI.

Characteristic parameter studies on the BWR and PWR for two plutonium fuel enrichments are given. These parametric studies include effects of fuel element assembly size on initial excess multiplication factor for a graded fuel loading, delayed neutron fraction calculations, prompt neutron lifetime as a function of fuel exposure, prompt neutron decay constant calculations and effects on reactivity and Doppler coefficients. All calculated data are shown graphically. (M.L.S.)

22659 (BNWL-606) NITRIDE FUELS FOR FAST BREEDER REACTORS: FUEL CYCLE CONSIDERATIONS. Fletcher, J. F.; Greenborg, J. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). Feb. 1968. Contract AT(45-1)-1830. 100p. Dep. CFSTI.

The nitrides of uranium and plutonium appear technically attractive as potential fuels for fast breeder reactors. To examine the potential economic status of the nitrides in commercial power production, a study was made to develop comparative fuel cycle costs for nitride and carbide fuels in a 1000 MW(e) sodium-cooled fast breeder reactor concept previously developed by Combustion Engineering, Incorporated. Results of the study indicate that nitrides would be competitive with carbides if low-cost processes for conversion of fuel materials to the nitrides were developed. The nitride fuels appear to contribute significantly toward a negative sodium-voiding coefficient. (auth)

22660 (DOCKET-50231-6) SOUTHWEST EXPERIMENTAL FAST OXIDE REACTOR. Facility Description and Safety Analysis Report, Amendment 9, Suppl. 6. (General Electric Co., Sunnyvale, Calif. Advanced Products Operation). Feb. 14, 1968. 8p. Dep. CFSTI.

A seismicity analysis for the SEFOR site is given. Earthquake effects on sodium coolant piping are tabulated. Results of a static load seismicity analysis for Class I systems are listed. (M.L.S.)

22661 (DOCKET-50231-7) SOUTHWEST EXPERIMENTAL FAST OXIDE REACTOR. Facility Description and Safety Analysis Report, Amendment 9, Suppl. 7. (General Electric Co., Sunnyvale, Calif. Advanced Products Operation). Feb. 14, 1968. 17p. Dep. CFSTI.

Additional information on the containment design for SEFOR is given. Included are: descriptions of the inner and outer containment structures, details on penetrations, and construction assignments. (M.L.S.)

22662 (DOCKET-50231-8) SOUTHWEST EXPERIMENTAL FAST OXIDE REACTOR. Facility Description and Safety Analysis Report, Amendment 10, Suppl. 8. (General Electric Co., Sunnyvale, Calif. Advanced Products Operation). Feb. 29, 1968. 46p. Dep. CFSTI.

Mechanical design calculations and analyses for the SEFOR shields are given. Included are: primary shield–design description, component design and analysis, fabrication, and installation; bottom shield–design description, component design and analysis, fabrication, and installation. Temperature distribution calculations are detailed. (M.L.S.)

22663 (DOCKET-50231-9) SOUTHWEST EXPERIMENTAL FAST OXIDE REACTOR. Facility Description and Safety Analysis Report, Amendment 10, Suppl. 9. (General Electric Co., Sunnyvale, Calif. Advanced Products Operation). Feb. 29, 1968. 202p. Dep. CFSTI.

A detailed description of the SEFOR shielding is given. Energy absorption rates for the various shield components are detailed. Neutron and gamma dose rate calculations during operation are given for the outsides of the biological shielding, nitrogen inlet plenum, refueling cell, and new-fuel storage vault. Shutdown dose rates are given for the reflector drive cell, refueling cell, head and vessel area, sodium equipment cell, and sodium-trap cell. Dose rate calculations for reactor materials are detailed. Sodium, nitrogen, and argon activities are calculated; fission product activities are tabulated. Appendices contain: Mockup of SEFOR Shielding Geometry and Compositions; Energy Balance in SEFOR shield; Gamma Shielding Constants; Cross Sections; Removal Theory Treatment of Deep Penetration of Neutrons; and Derivation of Gamma Attenuation Equations. 13 references. (M.L.S.)

22664 (DOCKET-50231-10) SOUTHWEST EXPERIMENTAL FAST OXIDE REACTOR. Facility Description and Safety Analysis Report, Amendment 11, Suppl. 10. (General Electric Co., Sunnyvale, Calif. Advanced Products Operation). Feb. 29, 1968. 230p. Dep. CFSTI.

A complete design analysis of the SEFOR core is given. Included are: core thermal-hydraulic design; steady state temperature distributions within a SEFOR fuel channel; transient analysis; core channel structural analysis; fuel rod structural analysis; fuel thermal performance; core element description; mechanical design evaluation; computer codes and cross sections; precision of power peaking factors; precision of maximum positive reactivity from loss of sodium; and excess reactivity in the core. Appendices contain: Flow Distribution Measurements in a 3-Scale Model of the SEFOR Fuel Bundle; A Solid-Liquid Phase Diagram for the UO_2–PuO_2 System; and Computer Codes Used in the SEFOR Core Analysis. (M.L.S.)

22665 (DOCKET-50231-11) SOUTHWEST EXPERIMENTAL FAST OXIDE REACTOR. Facility Description and Safety Analysis Report, Amendment 12, Suppl. 11. (General Electric Co., Sunnyvale, Calif. Advanced Products Operation). Mar. 6, 1968. 149p. Dep. CFSTI.

Additional information on the SEFOR reflector control system is given. Included are: design criteria and summary of drive characteristics; reflector guide structure; reflector control rod; drive mechanism; hydraulic system; development testing; and evaluation. Appendices contain: Thermal Hydraulics Analysis of Guide Structure and Segment; Structural Analysis of Control Segments and Guide Structure; Extension Shaft Analysis; and Reflector Segment Drop. (M.L.S.)

22666 (DOCKET-50231-12) SOUTHWEST EXPERIMENTAL FAST OXIDE REACTOR. Facility Description and Safety Analysis Report, Amendment 13, Suppl. 12. (General Electric Co., Sunnyvale, Calif. Advanced Products Operation). Mar. 11, 1968. 78p. Dep. CFSTI.

Additional information on SEFOR electrical power systems is given. Included are: electrical power systems, electrical auxiliary systems, electrical systems design evaluation, and process sodium pumps power supplies. (M.L.S.)

22667 (DOCKET-50231-13) SOUTHWEST EXPERIMENTAL FAST OXIDE REACTOR. Facility Description and Safety Analysis Report, Amendment 13, Suppl. 13. (General Electric Co., Sunnyvale, Calif. Advanced Products Operation). Mar. 11, 1968. 31p. Dep. CFSTI.

The design of the irradiated fuel storage equipment for SEFOR is detailed. Included are: design criteria, design evaluation, manufacturing and quality control, operation and instrumentation, and design drawings. (M.L.S.)

22668 (DOCKET-50231-14) SOUTHWEST EXPERIMENTAL FAST OXIDE REACTOR. Facility Description and Safety Analysis Report, Amendment 13, Suppl. 14. (General Electric Co., Sunnyvale, Calif. Advanced Products Operation). Mar. 11, 1968. 12p. Dep. CFSTI.

The quality control program for the sodium cooling systems for SEFOR is detailed. Descriptions of the quality control plan, materials, fabrication and testing, site quality control, and record keeping are included. (M.L.S.)

22669 (DOCKET-50231-15) SOUTHWEST EXPERIMENTAL FAST OXIDE REACTOR. Facility Description and Safety Analysis Report, Amendment 13, Suppl. 15. (General Electric Co., Sunnyvale, Calif. Advanced Products Operation). Mar. 11, 1968. 207p. Dep. CFSTI.

A design analysis of the main sodium piping, pumps, and heat exchangers for SEFOR is given. Detailed design information on the intermediate heat exchanger and air blast cooler is given; this includes the original design report from the manufacturer. Detailed design information and drawings are given on the sodium pumps and piping. (M.L.S.)

22670 (DOCKET-50245-1) MILLSTONE POINT NUCLEAR POWER STATION, UNIT 1. Final Safety Analysis Report, Amendment 5, Vol. 1. (Connecticut Light and Power Co., Hartford. Hartford Electric Light Co., Conn. Western Massachusetts Electric Co., Greenfield. Millstone Point Co., Wethersfield, Conn.). Mar. 14, 1968. 406p. Dep. CFSTI.

Information on Millstone Point Power Reactor, Unit I, is given under the following broad topics: Introduction and Summary, Site and Environs including site description, meteorology, hydrology, geology and seismology, marine biology, and environmental radiation monitoring program; Reactor Core and Intervals; Reactor Coolant System; and Containment Systems including primary containment system which is a pressure suppression system and secondary containment system which is the reactor building. (M.L.S.)

22671 (DOCKET-50245-2) MILLSTONE POINT NUCLEAR POWER STATION, UNIT 1. Final Safety Analysis Report, Amendment 5, Vol. 2. (Connecticut Light and Power Co., Hartford. Hartford Electric Light Co., Conn. Western Massachusetts Electric Co., Greenfield. Millstone Point Co., Wethersfield, Conn.). Mar. 14, 1968. 388p. Dep. CFSTI.

Information on Millstone Point Power Reactor, Unit I, is given under the following broad headings: Engineered Safeguards; Instrumentation and Control; Electrical System; Radiation Protection and Radioactive Waste; Auxiliary and Emergency Systems; Turbine, Condensate and Feedwater System; and Structures and Shielding. (M.L.S.)

22672 (DOCKET-50245-3) MILLSTONE POINT NUCLEAR POWER STATION, UNIT 1. Final Safety Analysis Report, Amendment 5, Vol. 3. (Connecticut Light and Power Co., Hartford. Hartford Electric Light Co., Conn. Western Massachusetts Electric Co., Greenfield. Millstone Point Co., Wethersfield, Conn.). Mar. 14, 1968. 202p. Dep. CFSTI.

Information on Millstone Point Power Reactor, Unit I, is presented under the following broad topics: Conduct of Operations and Safety Analysis including a summary description of safety features, design basis accidents, and radiological dose and effects calculational methods. Site environmental factors are analyzed in detail. (M.L.S.)

22673 (DOCKET-50277-3) PEACH BOTTOM ATOMIC POWER STATION, UNITS NO. 2 AND 3. Preliminary Safety Analysis Report, Amendment 1, Suppl. 1. (Philadelphia Electric Co., Pa.). July 11, 1967. 80p. (DOCKET-50278-3). Dep. CFSTI.

Information on Peach Bottom Power Reactor, Units 2 and 3, is presented under the following broad topics: General, which includes design for in-service inspection and evaluation of applicability of ACRS findings on Brown's Ferry to Peach Bottom; supplemental material on siting; Reactor and Plant Design; Radioactive Waste Control; Engineered Safety Features; Safety Analysis; Instrumentation and Control; and Electrical Systems. (M.L.S.)

22674 (DOCKET-50277-4) PEACH BOTTOM ATOMIC POWER STATION, UNITS NO. 2 AND 3. Preliminary Safety Analysis Report, Amendment 2, Suppl. 2. (Philadelphia Electric Co., Pa.). Sept. 8, 1967. 90p. (DOCKET-50278-4). Dep. CFSTI.

In addition to answers to AEC questions on Peach Bottom Power Reactor, Units 2 and 3, a stability analysis of boiling water reactors is given. (M.L.S.)

22675 (DOCKET-50280-16) SURRY POWER STATION, UNITS 1 AND 2. Preliminary Safety Analysis Report, Amendment 11. (Virginia Electric and Power Co., Richmond). Mar. 18, 1968. 21p. (DOCKET-50281-16). Dep. CFSTI.

Additional information on the control systems and instrumentation for Surry Power Reactor, Units 1 and 2 is given. (M.L.S.)

22676 (DOCKET-50285-17) FORT CALHOUN STATION, UNIT NO. 1. Safety Evaluation by the Division of Reactor Licensing. (Omaha Public Power District, Nebr.). Mar. 20, 1968. 95p. Dep. CFSTI.

The complete safety evaluation, by the AEC, Division of Reactor Licensing, of the Fort Calhoun Power Reactor, Unit 1 is given. (M.L.S.)

22677 (DOCKET-50313-2) RUSSELLVILLE NUCLEAR UNIT, APPLICATION FOR LICENSES. (Arkansas Power and Light Co., Little Rock). Nov. 24, 1967. 80p. Dep. CFSTI.

The application for license for the Russellville Nuclear Power Plant is presented. Included are: financial statements of the owner, Arkansas Power and Light Company; annual report to the shareholders of Arkansas Power and Light; and technical qualifications and experience of the company, its staff and contractors for the Russellville Unit. (M.L.S.)

22678 (DOCKET-50313-3) RUSSELLVILLE NUCLEAR UNIT. Preliminary Safety Analysis Report, Vol. 1. (Arkansas Power and Light Co., Little Rock). Nov. 29, 1967. 500p. Dep. CFSTI.

Volume 1, Docket 50-313, of the Preliminary Safety Analysis Report for Russellville Power Reactor contains: Introduction and Summary which includes tabular characteristics, principal design criteria, and identification of contractors; Site and Environment; Reactor which includes design bases, reactor designs, and tests and inspections; Reactor Coolant System which includes design bases, system description and operation, system design evaluation, and tests and inspection; Containment System which includes structural design, design through construction of penetrations, containment accessibility criteria, isolation system, ventilation system, leakage monitoring system, construction practices and quality control, and containment system inspection testing and surveillance; Engineered Safeguards; Instrumentation and Control; Electrical Systems; Auxiliary and Emergency Systems; and Steam and Power Conversion Systems. (M.L.S.)

22679 (DOCKET-50313-4) RUSSELLVILLE NUCLEAR UNIT. Preliminary Safety Analysis Report, Vol. 2. (Arkansas Power and Light Co., Little Rock). Nov. 29, 1967. 260p. Dep. CFSTI.

Volume 2, Docket 50-313, of the Preliminary Safety Analysis Report for Russellville Power Reactor contains: Radioactive Waste and Radiation Protection; Conduct of Operations including organization and responsibility, training, written procedures, records, and administrative control; Initial Tests and Operation; Safety Analyses including core and coolant boundary protection analysis and standby safeguards analysis; and Technical Specifications. Appendices contain detailed information on: technical qualifications, meteorology, surface water hydrology, ground water hydrology, geology, seismology, structures design bases containment proof tests, specifications for splicing, load factors and load combinations, yield reduction factors, containment structural analysis, field welding procedure, and containment instrumentation. (M.L.S.)

22680 (DOCKET-50319-1) BELL STATION. Preliminary Safety Analysis Report, Vol. 1. (New York State Electric and Gas Corp., Binghamton). Mar. 25, 1968. 300p. Dep. CFSTI.

The application for authorization to construct and operate the Bell Station Power Reactor comprises the following sections: Introduction and Summary; Site and Environs; Reactor Core; Reactor Coolant System; Containment Systems including pri-

mary and secondary containment systems; and Engineered Safeguards including summary description, emergency core cooling system (ECCS), main steam line flow restrictors, control rod velocity limiters, control rod drive housing supports, reactor standby liquid control system, and containment atmospheric control system. (M.L.S.)

22681 (DOCKET-50319-2) BELL STATION. Preliminary Safety Analysis Report, Vol. 2. (New York State Electric and Gas Corp., Binghamton). Mar. 29, 1968. 368p. Dep. CFSTI.

The application for authorization to construct and operate the Bell Station Power Reactor comprises the following sections: Instrumentation and Control Systems; Electrical Power Systems; Auxiliary Systems; Power Conversion Systems; Structures and Shielding; Operations; and Safety and Accident Analyses including incident analyses, design basis accident analyses, and analytical methods. (M.L.S.)

22682 (DOCKET-50319-3) BELL STATION. Preliminary Safety Analysis Report, Vol. 3. (New York State Electric and Gas Corp., Binghamton). Mar. 29, 1968. 252p. Dep. CFSTI.

Seismic design criteria for the Bell Station Power Reactor is given; predicted core performance characteristics are summarized. A detailed description and analysis of the control rod drive system is included. The in-core jet pump development program is described. The reactor core spray cooling test program is detailed; proposed technical specifications are outlined. Station compliance with AEC General Design Criteria is indicated by PSAR section. (M.L.S.)

22683 (DUN-1617) REACTOR PERSONNEL TRAINING STUDY. Report on Project MFC-10. Bursey, R. J. (Douglas United Nuclear, Inc., Richland, Wash.). June 1967. Contract AT(45-1)-1857. 83p. Dep. CFSTI.

The results of a study on the requirements and facilities available for training of reactor operating personnel training are given. Questionnaire and personal contact are the methods used for obtaining data from industrial firms, AEC laboratories, and schools and colleges. (M.L.S.)

22684 (EUR-3734) CONSIDERAZIONI SU UN METODO SPETTRALE DIRETTO PER L'IDENTIFICAZIONE DEI SISTEMI LINEARI. (Considerations on a Direct Spectral Method for Identification Linear Systems). Garroni, A. (European Atomic Energy Community, Ispra (Italy). Joint Nuclear Research Center). Feb. 1968. 116p. (In Italian). Dep.

A direct harmonic method for power spectral density analysis is developed. This method utilizes the analysis of signals of finite mean value and is suitable for use on digital computers. The determination of the spectral resolution of measurement is achieved mathematically. The evaluation of the statistical distribution of random signals allows evaluation of the measurement errors in the determination of power spectra, cross-spectra, and transfer functions. The systematic errors related to the use of a digital technique are examined and it is observed that they are principally due to the distortion of the kernels in the harmonic expansion. The sampling of the signals for digital processing does not affect the statistics of results. (auth)

22685 (EUR-3890) PROGRAMMA PER L'UTILIZZAZIONE DEL PLUTONIO NEI REATTORI TERMICI. (Programme for Use of Plutonium in Thermal Reactors). (Ente Nazionale per l'Energia Elettrica, Rome (Italy)). Dec. 4, 1967. 54p. (In Italian). Dep.

The uranium fuel cycles for the two power plants at Trino Vercellese and Garigliano were calculated, establishing the frequency and magnitude of reloads and the movements of fuel, and then the equivalent plutonium cycles were calculated. Taking the reference case for both plants to be the fuel cost calculated with an annual interest rate of 7.5% and a manufacturing price supplement of $20/kg, the industrial value of the fissionable plutonium was worked out to be $7.72/g as to the Garigliano plant and $7.90/g as to the Trino plant. The ENEL therefore decided to carry out the experimental part of the research programme in the Garigliano reactor by introducing prototype plutonium-containing fuel elements into it. Work continued on the MOVEL, ALTHAEA, METHUSELAH II, ZADOC, BOLERO, BURNY, THERMOS, TEMPEST, FORM, GAM II, PDQ, and FLARE codes for computing plutonium-containing lattices. The preliminary calculations to evaluate the number of prototype plutonium elements needed to reach a critical minimum showed that the eight elements now being fabricated are amply sufficient for these experiments. The nuclear characteristics of these elements have been studied. The elements will have three different fissionable Pu enrichments: 2.85%, 1.40%, and 0.74%. A study was conducted to compare the dynamic behavior of the Trino Vercellese and Garigliano plants with cores loaded with uranium and plutonium respectively. (auth)

22686 (EURAEC-1996) RESEARCH PROGRAM ON THE STEADY STATE AND DYNAMIC BEHAVIOUR OF A BOILING WATER REACTOR. Final Report No. 3. (Technische Hogeschool, Eindhoven (Netherlands)). Jan. 1968. Contract 030-64-1-Teen. 68p. (EUR-3789; WW-016-R-123). Dep. CFSTI.

Work performed under United States-Euratom Joint Research and Development Program.

The research program on the heat transfer and stability characteristics of a boiling water system under pressures up to 40 atm is summarized. Short descriptions of the experimental set-up and the instrumentation are presented, and a few of the experiments are described. Measurements with natural circulation are reported and compared with measurements under forced circulation. The state of development of the theoretical models is summarized. (H.D.R.)

22687 (EURFNR-458) GENERAL CRITERIA TO OPTIMIZE THE OPERATION OF A POWER PLANT WITH SPECIAL CONSIDERATION TO ITS SAFETY REQUIREMENTS. Caldarola, L.; Weber, G. (Kernforschungszentrum, Karlsruhe (West Germany). Institut fuer Angewandte Reaktorphysik). Aug. 1967. 141p. (KFK-640; EUR-3685). Dep.

Work performed under United States-Euratom Fast Reactor Exchange Program.

To increase the availability of a power plant means also to invest more money in the plant. A criterion to weigh the improved availability against the increased plant cost is therefore needed. For this reason, the annual loss function of a power plant is introduced: the minimum of this function gives the best balance between improved availability and increased plant cost. The safety requirement is a constraint to the problem of finding the minimum of the function. The mathematical expressions to calculate the annual loss function are derived, and a numerical example is also included. Some general probabilistic considerations on reactor containers are also discussed. (auth)

22688 (GA-7549) DESCRIPTION AND RESULTS OF THE P13G COATED PARTICLE IRRADIATION EXPERIMENT. Luby, C. S.; Schwartz, A. S.; Spillane, B. B. (Gulf General Atomic, Inc., San Diego, Calif.). Dec. 1, 1966, Issued Feb. 8, 1968. Contract AT(04-3)-167. 33p. Dep. CFSTI.

Capsule P13G, in which several types of Buffer-Isotropic-coated carbide fuel particles were tested, was irradiated to estimated fuel burnups of 4% and 1% fissions per initial heavy metal atom (FIMA), for fissile and fertile particles, respectively, at estimated temperatures of 1250° to 1400°C. One cell reached an estimated 1900°C. The average temperature was 1350°C. Results of postirradiation examination indicate that: fissile particles show slight coating failure at low burnup (~4% FIMA) when the ratio of coating thickness to particle diameter (T/D) is 0.33, but show no failure at T/D $\geq$ 0.38, and fertile particles (T/D = 0.3) survived 1% burnup; and coated fissile (T/D = 0.5) and fertile (T/D = 0.3) particles irradiated to 4% and 1% burnup, respectively, survived at ~1250 to 1400°C but experienced 25% failure at an estimated temperature of 1900°C. (auth)

22689 (GA-8416) BLOOST-6: A COMBINED REACTOR KINETICS -HEAT TRANSFER PROGRAM. Merrill, M. H. (Gulf General Atomic, Inc., San Diego, Calif.). Dec. 15, 1967. Contract AT(04-3)-167. 34p. Dep. CFSTI.

A complete description and listing of the BLOOST-6 computer program is given. BLOOST-6 is a combined reactor kinetics-heat transfer code written in FORTRAN-IV for the Univac-1108. The code is applicable only to problems for which the space-independent form of the reactor kinetics equation is valid. Subroutines used with the BLOOST-6 code are detailed; input data samples are shown. The required UNIVAC-1108 starter deck is described. Initial conditions and running times are given; error stops are listed. A simplified flow diagram is shown. (M.L.S.)

22690 (GA-8500) 40-MW(E) PROTOTYPE HIGH-TEMPERATURE GAS-COOLED REACTOR POSTCONSTRUCTION RESEARCH AND DEVELOPMENT PROGRAM. Quarterly Progress Report for the Period Ending January 31, 1968. (Gulf General Atomic, Inc., San Diego, Calif.). Feb. 28, 1968. Contract AT(04-3)-314. 50p. Dep. CFSTI.

PEACH BOTTOM POWER REACTOR, UNIT 1—operations during November to January 1968; shutdown reactivity of effects of xenon-135 on; startup reactivity of, effects of xenon-135 on; cooling system for, effectiveness of helium purification assembly in
XENON-135—reactivity effects on Peach Bottom Power Reactor Unit 1, analysis of
REACTOR FUEL ELEMENTS—shipping cask for Peach Bottom Power Reactor Unit 1, temperature analysis for
SHIELDED CONTAINERS—temperature analysis of Peach Bottom Power Reactor Unit 1 fuel element shipping cask

HANDLING AND STORAGE — equipment for Peach Bottom Power Reactor Unit 1 fuel elements
ARGON-41 — activity measurement in Peach Bottom Power Reactor Unit 1 cooling system
REACTOR FUEL ELEMENTS — burnup of Peach Bottom Power Reactor Unit 1, measurement of fission products from
KRYPTON-88, KRYPTON-89, KRYPTON-87, XENON-133, XENON-135, XENON-138, IODINE-133, IODINE-135 — activity measurement in Peach Bottom Power Reactor Unit 1 fuel assembly
HELIUM — purification system for Peach Bottom Power Reactor Unit 1, analysis for impurities from
HEAT TRANSFER SYSTEMS — activity measurements in Peach Bottom Power Reactor Unit 1 primary (D.C.C.)

22691 (GA-8115) A STATISTICAL ANALYSIS OF THE EFFECTS OF REGIONAL FUEL LOADING TOLERANCES ON FLUX TILTING IN THE FORT ST. VRAIN HTGR. Stevens, D. W. (Gulf General Atomic, Inc., San Diego, Calif.). Dec. 15, 1967. Contract AT(04-3)-633. 66p. Dep. CFSTI.

Scatter in the fuel loadings of refueling regions can result in scatter in regional flux (i.e., flux tilt). The statistical distribution of flux tilt can be established by using a cause and effect relation between fuel loadings and flux tilt, thereby providing a net power distribution. Such a relation is used to make Monte Carlo computations of flux tilt for the Fort St. Vrain High-Temperature Gas-Cooled Reactor (HTGR). The Monte Carlo computations are conducted for each of the 37 regions of the Fort St. Vrain core. The computations are repeated for each of 1000 cores, and the maximum flux tilt for each core is tabulated. The Monte Carlo computations show that fuel loadings having a Gaussian or normal distribution with a standard deviation of 0.2% of nominal loading result in a high level of confidence that regional flux tilt in a core will not exceed 2.4%. Analytical techniques are employed to derive the distribution of maximum flux tilt. The derived distribution compares favorably with the Monte Carlo computations. The influence of the type of distribution of fuel loadings on the distribution of flux tilt is investigated by comparing the above results with both analytical and Monte Carlo results for uniformly distributed fuel loadings. Changing the distribution of fuel loadings to a uniform distribution between the tolerance limits of ±1% of nominal results in a large increase in flux tilting. It is also shown that fuel loadings having a normal distribution with a standard deviation of 0.2% of nominal result in a high level of confidence that all 37 regions will meet the ±1% fuel loading tolerance. (auth)

22692 (GAMD-7902) PEACH BOTTOM HELIUM PURIFICATION SYSTEM PERFORMANCE. Results of Postconstruction R and D Test Procedures DE-2, DE-3, GE-2 and GE-3. Westlake, W. J.; Stelling, H. E. (Gulf General Atomic, Inc., San Diego, Calif.). Jan. 31, 1968. Contract AT(04-3)-314. 15p. Dep. CFSTI.

Testing of the Peach Bottom Atomic Power Station helium purification system and the chemical cleanup subsystem was performed during initial approach-to-power operations. The testing indicated that the systems met all design requirements for controlling impurity levels in the helium coolant. The pressure drop in the helium purification system was higher than design, but did not adversely affect the system cleanup capabilities. Actual operating conditions of the systems at 30% and 100% of full power are given. (auth)

22693 (GAMD-7908) NOISE ANALYSIS MEASUREMENT DURING RISE TO POWER IN PEACH BOTTOM. (Results of Post Construction R and D Procedures DP-6 and GP-7). Brown, J. R.; Weiman, A. L. (Gulf General Atomic, Inc., San Diego, Calif.). Feb. 7, 1968. Contract AT(04-3)-314. 19p. Dep. CFSTI.

Results of noise analysis measurements in Peach Bottom Power Reactor, Unit 1 from zero to full power are given. Equipment used for the testing is described; block diagrams of instrumentation are given. Instrumentation output is in the form of log-log plots of voltage vs. frequency; these are included. (M.L.S.)

22694 (GAMD-7912) CONTROL ROD CALIBRATIONS DURING INITIAL RISE TO POWER IN PEACH BOTTOM. (Results of Post Construction R and D Procedure DP-9). Brown, J. R.; Van Howe, K. R. (Gulf General Atomic, Inc., San Diego, Calif.). Jan. 22, 1968. Contract AT(04-3)-314. 22p. Dep. CFSTI.

Control rod calibrations in Peach Bottom Power Reactor, Unit 1 are described; use of an on-line reactivity computer for rod calibration between 1 MWt and 70 MWt is discussed. Results of reactivity calculations using the BLOOST code are shown. Reactivity changes for rod withdrawal and insertion are presented graphically. Integral worth values are tabulated; some integral and differential rod worth curves are included. (M.L.S.)

22695 (GEAP-5309) EVALUATION OF THE EFFECT OF DESIGN AND OPERATING VARIABLES ON SEFOR FUEL AND FUEL CLADDING. Field, J. H.; Johnson, M. L.; Novak, P. E. (General Electric Co., Sunnyvale, Calif. Advanced Products Operation). Dec. 1967. Contract AT(04-3)-540. 72p. Dep. CFSTI.

Fourteen capsule experiments were irradiation-tested to investigate design parameters and expected operating conditions on SEFOR fuel. Irradiation tests of SEFOR fuel with reference design cladding thickness and fuel-cladding gaps subjected to expected steady-state and power oscillation conditions resulted in no cladding distortion. Similar specimens subjected to TREAT transients to near fuel melting experienced minor cladding ridges at the fuel pellet interfaces. Cladding maintained its integrity during all tests including non-standard conditions of operation above melting of fuel, reduced fuel-cladding gaps, and sodium ingress into the fuel prior to transient. (auth)

22696 (GEAP-5440) FLUID FLOW AND VIBRATION TESTS ON 1/2-SCALE MODEL OF THE SEFOR REACTOR VESSEL. Polomik, E. E.; Russell, C. E.; Quinn, E. P. (General Electric Co., Sunnyvale, Calif. Advanced Products Operation). Apr. 1967. Contract AT(04-3)-540. 100p. Dep. CFSTI.

Tests were conducted on the fluid flow and vibration characteristics in a half-scale model of the SEFOR (Southwest Experimental Fast Oxide Reactor) reactor vessel. Water, at temperatures up to 265°F, was used to simulate coolant conditions in the sodium-cooled reactor. Flows were varied from 10 to 100% of rated Reynolds number in the reactor. Data was obtained on relative core flow distribution, flow patterns, pressure losses, and vibration characteristics of the cantilever-mounted core shroud. Fluid flow results provided information necessary for verification of final design. Vibration results indicated no serious effects of amplitude or stress in the full-scale reactor. (auth)

22697 (GEAP-5560) REFUELING CELL STUDIES, JULY 5, 1967–JULY 25, 1967. SODIUM COMPONENTS DEVELOPMENT PROGRAM MASS TRANSFER INVESTIGATIONS IN LIQUID METAL SYSTEMS. Steamer, Arnold G. (General Electric Co., Sunnyvale, Calif. Advanced Products Operation). Nov. 1967. Contract AT(04-3)-189. 36p. Dep. CFSTI.

A specific program of tests conducted in the SEFOR Refueling Cell Mockup for the purpose of providing information on sodium vapor-aerosol transport and deposition as they relate to visual fuel handling methods at sodium temperatures of 450 to 500°F is discussed. (auth)

22698 (GEAP-5591) POWER REACTOR HIGH PERFORMANCE UO_2 PROGRAM. FUEL DESIGN SUMMARY AND PROGRAM STATUS. Ogawa, S. Y.; Lees, E. A.; Lyons, M. F. (General Electric Co., San Jose, Calif. Nuclear Fuels Dept.). Jan. 1968. Contract AT(04-3)-189. 79p. (EURAEC-2001). Dep. CFSTI.

Work Performed under United States–Euratom Joint Research and Development Program.

The irradiation of six fuel bundles containing 324 rods in the Consumers Power Company Big Rock Point (BRP) reactor will be used to evaluate UO_2 centermelt in fuel rods. Two discrete levels of melting will be evaluated. Two bundles contain 0.570-inch-o.d., Zircaloy-2-clad rods, half with vipak powder and half with pellet UO_2 fuel, and will operate with incipient centermelting. The other four bundles contain 0.700-inch-o.d., Zircaloy-2-clad rods, also half with vipak powder and half with pellet UO_2 fuel, and will operate with definite but moderate centermelting at rated power. The detailed fuel design, fuel fabrication, safeguards analysis, and relicensing of the Big Rock Point reactor for the irradiations are presented. (auth)

22699 (HPR-80) IN-PILE DETERMINATION OF UO_2 THERMAL CONDUCTIVITY, DENSITY EFFECTS, AND GAP CONDUCTANCE. Kjaerheim, G.; Rolstad, E. (Institutt for Atomenergi, Halden (Norway). OECD Halden Reaktor Prosjekt). Dec. 1967. 85p. Dep.

Fuel temperature measurements made in two instrumented fuel assemblies in the Halden Reactor are described. Effects of fuel density and gap between fuel and clad are determined. Burnup effects are evaluated also. Values for thermal conductivity are given. Radial clad strain is analysed. The mathematical model used for temperature calculations is described. 35 references. (M.L.S.)

22700 (HPR-81) COMPILATION OF TEST FUEL DATA OF THE 1964-66 TEST FUEL PROGRAMME. Knudsen, K. D.; Majoor, E. B. M. (Institutt for Atomenergi, Halden (Norway). OECD Halden Reaktor Prosjekt). Dec. 1967. 128p. Dep.

Thirty-eight fuel assemblies have been irradiated during the 1964–66 period in HBWR. The data of the various assemblies are compiled in this report. (auth)

22701 (HPR-93) FISSION PRODUCT MONITORING SYSTEMS AND FUEL FAILURES AT HBWR. Oeyen Hol, J.; Wullum, T. (Institutt for Atomenergi, Halden (Norway). OECD Halden Reaktor Prosjekt). Dec. 1967. 49p. Dep.

The fuel failure detection and location systems have in general operated satisfactorily. During all fuel failures the water phase monitor has given adequate response at normal window settings. Through spectrum analysis, which is carried out daily, minute amounts of fission products or chlorides present in the moderator will be detected. Very good results were also obtained with this monitor during the flux tilting experiment. The experience gained with the failure location system shows that the system's capability to locate a failed UO_2 assembly will be satisfactory provided that no water is carried over with the sampled steam. Recirculation of activity which probably occurred when a vibratory compacted UO_2 assembly failed, gave erroneous results. A recent fuel failure indicates that such recirculation will take place when fission products are released from a vibratory compacted UO_2 fuel assembly. Operation with failed assemblies has resulted in release of a number of isotopes. The most important isotopes released to the atmosphere from a radiation hazard point of view were the noble fission gases Xe-133 and Xe-135. I-131 was mostly released after the reactor had been cooled down and depressurized, thus largely eliminating leakage of this isotope from the primary circuit. The fuel failures have not resulted in contamination of the primary circuit for longer periods. (auth)

22702 (JAERI-1151) DESIGN OF PLUTONIUM SELF-SUSTAINING REACTOR. HEAVY WATER MODERATED BOILING LIGHT WATER COOLED. Sawai, S.; Yasukawa, S.; Shinoda, W. (Japan Atomic Energy Research Inst., Tokyo). Aug. 1967. 13p. (CONF-670917-12). Dep.

From Symposium on Heavy Water Power Reactors, Vienna, Austria.

Design parameters for the plutonium self-sustaining power reactor are tabulated. The results of the feasibility study are discussed. Minimum burnout ratios are shown; core transient response is given. Structural design aspects are outlined. 19 references. (M.L.S.)

22703 (KFK-660) SCHNELLER NATRIUMGEKUEHLTER REAKTOR Na 2. (Sodium-Cooled Fast Reactor Na 2). Gast, K.; Schlechtendahl, E. G. (Kernforschungszentrum, Karlsruhe (West Germany). Institut fuer Reaktorentwicklung). Oct. 1967. 286p. (In German). (EUR-3706). CFSTI.

A complete description of the Fast Sodium Cooled Reactor Na-2 is given. This includes: bases and goals for the studies; data tables on systems operating parameters, the reactor, primary and secondary systems, emergency cooling system, containment, turbines, and generators; a description of the installation; reactor operation; reactor physics calculations; cooling of the reactor core; safety; and economics. 37 references. (M.L.S.)

22704 (LA-3833) INTEGRAL-TRANSFORM LIE-SERIES ANALYSIS OF TRANSIENT TEMPERATURES IN REACTOR COOLANT CHANNELS. Axford, Roy Arthur (Los Alamos Scientific Lab., N. Mex.). Sept. 1967. Contract W-7405-eng-36. 24p. Dep. CFSTI.

A new method is developed for computing transient temperature fields in cylindrical reactor channels when the relative fuel power density, the coolant speed, and the channel inlet temperature are arbitrarily specified functions of time. Through the use of Hankel transforms, numerical instabilities inherent in finite difference approximations of spatial derivatives are avoided. Solutions of high order systems of ordinary differential equations in the time coordinate are efficiently obtained by a computational algorithm based upon the concept of Lie series. (auth)

22705 (NAA-SR-12503) TRANSFUGUE-IIa: A DIGITAL CODE FOR TRANSIENT TWO-PHASE FLOW IN SINGLE HEATED CHANNELS. Landoni, J. A. (Atomics International, Canoga Park, Calif.). Mar. 15, 1968. Contract AT(04-3)-701. 33p. Dep. CFSTI.

The TRANSFUGUE-IIa is an improved version of previous codes developed at Atomic International concerning the initiation of boiling in single heated channels, normally cooled by liquid metals. In particular, the present study supersedes the TRANSFUGUE-I code reported in NAA-SR-11008, as well as the succinct description of the TRANSFUGUE-IIa code in NAA-SR-TDR-12485. The main simplifying assumption in these computations is that the homogeneous hydrodynamic model (slipless flow) is obeyed during boiling conditions. In consequence the TRANSFUGUE-IIa code can be considered as a useful code for the computation of, for example, the transient states following a large insertion of reactivity or a sudden decrease in coolant supply pressure. The present code is not in its final form, and it is expected to be improved with more realistic assumption. (auth)

22706 (NYO-3250-9) ANALYSIS OF THE HEAT REMOVAL CAPABILITY OF THE CONTAINMENT AIR COOLING UNITS FOLLOWING A LOSS OF COOLANT INCIDENT. Hinkle, W. D. (Connecticut Yankee Atomic Power Co., Haddam). Dec. 30, 1966. 29p. (CYAP-102). Dep. CFSTI.

A description of four cooling units comprising the containment air recirculation system is presented. The heat removal capability of the cooling units for a loss of coolant incident and for several conditions characteristic of the transient which would follow is evaluated, and the method of analysis is described. (D.C.C.)

22707 (NYO-3250-10) CONNECTICUT YANKEE CHARCOAL FILTER TESTS. [DeVincentis, John] (Connecticut Yankee Atomic Power Co., Boston, Mass.). Dec. 1966. Contract AT(30-1)-3250. 103p. (CYAP-101). Dep. CFSTI.

Results of testing of charcoal containment filters under accident conditions are presented. The efficiency of the filters in removing radioactive methyl iodide was determined in the W APD filter test facility. The filters were tested in a loop system containing an air-steam mixture at about 261°F and 40 psig with sufficient steam present to maintain relative humidity at 100%. Testing times ranged from 10 to 24 hours. The methyl iodide concentration was determined by chromatographic analyses and the radiotracer (^{131}I) activity was determined in samples, removed from the loop, with a gamma spectrometer. (D.C.C.)

22708 (NYO-3250-11) THE STARTUP TEST PROGRAM FOR THE CONNECTICUT YANKEE REACTOR. (Connecticut Yankee Atomic Power Co., Haddam). Sept. 1967. 37p. Dep. CFSTI.

The test program conducted on the Connecticut Yankee Power Reactor is described; a core loading diagram is shown. Results of universe multiplication measurements are shown graphically. Procedures followed in control rod testing are outlined; rod drop times are tabulated. Approach-to-critical tests are described; data are given. Zero power physics measurements are outlined; $\Delta K/K$ measurements are shown as a function of position for rod banks A, B, and D. Differential and integral worth curves for boron are shown as a function of boron concentration in the coolant. Moderator temperature coefficient data are presented graphically. M.L.S.)

22709 (NYO-3622-13) APPLICATIONS OF ULTRASONIC ENERGY: ULTRASONIC INSTRUMENTATION FOR NUCLEAR APPLICATIONS. Bimonthly Progress Report No. 38, December 1, 1967-January 31, 1968. (Aeroprojects, Inc., West Chester, Pa.). Feb. 1968. Contract AT(30-1)-3622. 19p. Dep. CFSTI.

The modified test loop at Mine Safety Appliance Research Corporation, (MSAR) is ready for evaluation of the ultrasonic incipient boiling detector. The ultrasonic flowmeter, using water as a simulant for liquid metal, has been calibrated and comparisons of current data with earlier data are given. In order to obtain more realistic data, a program using molten sodium for calibrating a flowmeter has been initiated. A test loop at MSAR is available and discussions are underway to design and install a flowmeter in this loop. (auth)

22710 (ORNL-NSIC-42) INDEXED BIBLIOGRAPHY OF CURRENT NUCLEAR SAFETY LITERATURE-12. (Oak Ridge National Lab., Tenn.). Feb. 1968. Contract W-7405-eng-26. 454p. Dep. CFSTI.

Nuclear safety information is presented in bibliographic form. Each item contains author, title, corporate author, number of pages, tables, figures, references, date, document number, availability, and an abstract with selected keywords. The information is listed under 19 categories; these are: General Safety Criteria; Siting of Nuclear Facilities; Transportation and Handling of Radioactive Materials; Aerospace Safety; Accident Analysis; Reactor Transients, Kinetics, and Stability; Fission Product Release, Transport, and Removal; Sources of Energy Release Under Accident Conditions; Nuclear Instrumentation, Control, and Safety Systems; Electrical Power Systems; Containment of Nuclear Facilities; Plant Safety Features; Radiochemical Plant Safety; Radionuclide Release and Movement in the Environment; Environmental Surveys, Monitoring and Radiation Exposure of Man; Meteorological Considerations; Operational Safety and Experience; Safety Analysis and Design Reports; and Bibliographies. (M.L.S.)

22711 (STI/PUB-172) FUEL BURN-UP PREDICTIONS IN THERMAL REACTORS. Panel Proceedings Series. Proceedings of a Panel Held in Vienna, 10-14 April 1967. (International Atomic Energy Agency, Vienna (Austria)). 1968. 250p. (CONF-670418). IAEA: $5.00; Austrian Schillings 130,-; Pound 1.15.4; F Fr. 24,50; DM 20,-.

Included are 14 papers on local burnup, over-all burnup, and fuel management strategy in thermal reactors. Separate abstracts were

prepared for 12 papers. Abstracts of the 2 remaining papers may be located in previous issues of NSA under CONF-670418 in the report number index. (H.D.R.)

For abstracts of individual papers see: 22731–22739, 22844, 22880, and 22881.

22712 (STI/PUB-174) DIRECTORY OF NUCLEAR REACTORS. VOL. VII. POWER REACTORS. (International Atomic Energy Agency, Vienna (Austria)). 1968. 342p. plus map. IAEA: $9.00; Austrian Schillings 233,–; £3.3.6; F Fr 44,10; DM 36,–.

Supplement to Vol. IV.

Included are all available design, construction, economic, and status information on the following nuclear power reactors: N. S. Savannah, Enrico Fermi (SELNI-Italy), Ardennes (SENA-France), MH-1A, San Onofre, Obrigheine (KWO- Germany), Zorita-1 (Spain), Indian Point-2, NOK (Switzerland), Robert E. Guina, Malibu, Palisades, Point Beach-1, Surfside, Garigliano (SENN-Italy), Hanford-N Reactor, KRB (Germany), La Crosse, Oyster Creek, SGHWR (Britain), Dodewaard (Netherlands), Grosswelzheim (HDR-Germany), Lingen (KWL-Germany), Marviken (Sweden), Nine Mile Point, Dresden-2, Santa Maria La Garona (Spain), Tsuruga (Spain), Dresden-3, Oskarshamn (OKE-Sweden), MZFR (Germany), Pickering (Canada), Sizewell (Britain), EDF-3 (France), Peach Bottom-1, EL-4 (France), Lucens (Switzerland), Oldbury (Britain), Niederaichbach (KKN-Germany), EDF-4 (France), Wylfa (Britain), EDF-5 (France), Arbus (USSR), BN-350 (USSR), and KNK (Germany). (M.L.S.)

22713 (TID-24304) GARIGLIANO NUCLEAR POWER PLANT ANNUAL REPORT, 1964. (Ente Nazionale per l'Energia Elettrica, Rome (Italy)). 1965. 114p. Dep. CFSTI.

GARIGLIANO POWER REACTOR — operations during 1964; power testing for, description of; cooling system for, void fraction curves for; fuel burnup in, analysis of; cooling systems of, flow diagrams for

NEUTRONS, THERMAL — flux measurements for Garigliano Power Reactor fuel elements

REACTOR FUEL ELEMENTS — neutron flux distribution in Garigliano Power Reactor, thermal; burnup of Garigliano Power Reactor, analysis of

HEAT TRANSFER SYSTEMS — performance of Garigliano Power Reactor; flow diagrams for Garigliano Power Reactor

REACTIVITY — effects of varying recirculation flow on Garigliano Power Reactor

REACTOR CONTROL ELEMENTS — maintenance of Garigliano Power Reactor, description of

RADIATION DETECTORS, IONIZATION CHAMBER — maintenance of Gangliano Power Reactor, description of

FISSION PRODUCTS — measurement of Garigliano Power Reactor coolant

RADIATION MONITORING — measurements for Garigliano Power Reactor

REACTOR SAFETY — radiation monitoring of Garigliano Power Reactor (D.L.C.)

22714 ELECTRONUCLEAR STATIONS OF THE WORLD: IN PRODUCTION, CONSTRUCTION, AND DESIGN AS OF 1967. Com. Naz. Energ. Nucl., Notiz., 14: 55-65(Jan. 1968). (In Italian).

A tabular summary of world nuclear power plants is given by country. Included are: Argentina, Belgium, Bulgaria, Canada, Czechoslovakia, EURATOM, Finland, France, West Germany, East Germany, Japan, Great Britain, India, Italy, Netherlands, Pakistan, Spain, Sweden, Switzerland, Hungary, U.S.S.R., and U.S.A. (M.L.S.)

22715 EXPERIMENT AND EXPERIENCE WITH BR3/VULCAIN. Storrer, J. (Belgo Nucleaire, Brussels). Bull. Belgicatom, 12: No. 1, 3-11(May-June 1967).

A discussion of the history and operating history is given. Construction and commissioning are outlined; power output and plant statistics are tabulated. The experimental program is outlined. (M.L.S.)

22716 ENGINEERING DESIGN AND ANALYSIS OF A BERYLLIA-MODERATED PEBBLE BED REACTOR. Ebeling, D. R.; Hayes, J. E. (Australian Atomic Energy Commission, Lucas Heights). Mech. Chem. Eng. Trans., 119-37(May 1967).

The technical feasibility and economic potential of a pebble bed reactor using CO_2 cooling, BeO moderation, Pu–Th dispersion fuel, continuous re-fueling, and continuous recirculation of partially spent fuel elements are investigated. The 200 MW(e) reference design and the possible improvements in design indicated by the nuclear, materials, engineering, and economic analyses are described. (H.D.R.)

22717 NUCLEAR POWER GENERATION. Fujinami, Tsuneo. (Public Utilities Bureau, Japan); Egashira, Tadahiko. Karyoku Hatsuden, 18: 517-26(June 1967). (In Japanese).

In the special edition of Nuclear Power Generation are given the following articles: The trend of nuclear power generation in Japan, by T. Fujinami; The operation record and experiences of JPRD, by T. Egashira; Operation experiences of the Tokai power station, and the planning of the Tsuruga power station, by Y. Iwakoshi et al.; The planning of the Fukushima power station, by A. Nomura; the planning of the Mihama power station, by S. Okano; Boiling-water reactors, by R. Saito et al.; Pressurized water reactors, by T. Tsuda; Advanced converter reactors, by J. Abe; Development of fast breeder reactors in Europe and the United States, by R. Miki; Nuclear fuels, by Asanuma; A list of nuclear reactors in the world, by T. Kawahito. (NSA of Japan)

22718 PRESTRESSED CONCRETE VESSELS FOR NUCLEAR POWER STATIONS. Baekmark, K. (Danish Atomic Energy Commission, Risoe). Ing. Bygningsv., 63: No. 2, 35-8(1968). (In Swedish).

A review of the prestressed concrete pressure vessel for nuclear power reactors is given, mentioning advantages and disadvantages. The Danish work within this area is described with special reference to the Scandinavian cooperation in the building of a model vessel mainly for testing the insulation and a removable top. (auth)

22719 CURRENT PROBLEMS IN THE CONSTRUCTION OF REACTOR CONTAINMENTS. Karwat, H. (Technische Hochschule, Munich). Atomwirt., Atomtech., 12: 435-8(Aug.-Sept. 1967). (In German).

Problems associated with the construction of containment systems for large power reactors are examined. Those problems associated with pressure changes in high-pressure containment systems are discussed; residual heat removal under accident conditions is considered. Effects of metal-water reactions are analyzed. Efficiency of containment systems in preventing fission product release is evaluated. (M.L.S.)

22720 EXPERIENCE WITH THE SAFETY SYSTEMS OF GERMAN REACTORS. Bastl, W. (Technische Hochschule, Munich). Atomwirt., Atomtech., 12: 422-6(Aug.-Sept. 1967). (In German).

Safety systems of the VAK, KRB and MZFR reactors are shown in block diagram form; each is discussed briefly. Operating experience with each reactor is described; problems are discussed. (M.L.S.)

22721 OUTLINES OF A GENERAL SAFETY THEORY. Knecht, O. (INTERATOM, Bensberg, Ger.). Atomwirt., Atomtech., 12: 427-34(Aug.-Sept. 1967). (In German).

An outline of a statistical approach to reactor safety is given. A distribution function is developed for expected defects or malfunctions. A detailed concept of damage expectation is described; optimal lifetime of the power plant is determined in terms of systems differential equations. The method of application of the theory to reactor technology is described. (M.L.S.)

22722 NUCLEAR GUIDELINES AND STANDARDS: AN INTERNATIONAL TASK. Kellermann, O.; Patzelt, A. (Technische Ueberwachungs-Vereine eV, Cologne). Atomwirt., Atomtech., 12: 410-13(Aug.-Sept. 1967). (In German).

The role of the various national governments in fixing past standards and guidelines for the nuclear is discussed. The role of the industry, itself, in the future development of these standards and procedures is evaluated. Standards, guides, and procedures of international scope are proposed. (M.L.S.)

22723 DEVELOPMENT OF A SAFETY PHILOSOPHY BASED ON THE MODEL OF THE MCA. Wiesenack, G. (Technische Ueberwachungs-Vereine eV, Essen). Atomwirt., Atomtech., 12: 418-21(Aug.-Sept. 1967). (In German).

The Maximum Credible Accident safety philosophy is reviewed. Siting criteria used by the USAEC for licensing purposes are outlined; use of the concepts of exclusion area and population center distance is discussed. The procedures used by the UKAEA–determination of weight factors for a given site–are reviewed. The accident probability concept is examined. 19 references. (M.L.S.)

22724 PROPOSALS FOR IMPROVING THE LICENSING PROCEDURE ACCORDING TO THE ATOMIC LAW. Ellmer, M. Atomwirt., Atomtech., 12: 408-9(Aug.-Sept. 1967). (In German).

Proposals for licensing procedure modifications for the German Federal Republic are presented from the point of view of the owner and operator. Practical interpretation and

application of existing laws based on present technology is emphasized. In addition, compulsory fixing of terminal dates for execution of procedures, safety testing procedures which avoid delays, consideration of technological advances during the construction period, uniformity of procedure from country to country, and the resolution of the question of site licensing are proposed. (M.L.S.)

22725 IN-PILE HEAT-TRANSFER STUDIES OF ROUGHENED HELIUM-COOLED REACTOR FUEL ELEMENTS. Brandon, C. A.; Kidd, G. J. Jr. (Oak Ridge National Lab., Tenn.). Nucl. Sci. Eng., 32: 8-15(Apr. 1968). (ORNL-P-3397).

During a series of in-pile experiments designed to study irradiation effects on high-performance oxide fuel elements for advanced gas-cooled reactors, heat-transfer data were obtained from four specially instrumented fuel rods. An annular geometry was utilized with rods of 1.9- and 2.18-cm dia being contained in channels of 2.44- and 2.67-cm dia, respectively. The effects of wire-wrapped and machined square-thread surface roughness were measured and compared with the results obtained from a smooth rod. The fuel rods contained UO_2 pellets of varying enrichment and were clad with type-304 stainless-steel tubing. The test parameters for the data reported are: (1) coolant flow rate from 45 to 150 kg/h of helium at 20 atm which corresponds to Reynolds numbers from 15,000 to 45,000; (2) cladding temperatures at 840°C; and (3) heat fluxes from 30 to 100 W/cm^2. The smooth-rod data can be correlated with a standard deviation of ±10%. Roughening the rods increased the heat transfer by approximately a factor of 2 with no significant difference between the wire-wrapped and machined roughnesses. The results are generally found to be in good agreement with the results of previous heat-transfer studies. Some consequences of using heat-transfer promoters in nuclear reactor fuel elements are discussed. (auth)

22726 THE DEFECT IN THE EDF-3 BURST FUEL ELEMENT DETECTION PLANT. Toureau, P. (Electricite de France, Paris). Atomwirt., Atomtech., 12: 438-40(Aug.-Sept. 1967). (In German).

A description of the fuel-element-failure detection system in the EDF-3 is given. Failure of this detection system is described; measures taken to relieve failure causes are discussed. (M.L.S.)

22727 EVOLUTION OF HOT-CHANNEL FACTORS FOR SHIPPINGPORT REACTOR CORES. Atherton, Richard. Reactor Fuel-Process. Technol., 10: 261-70(Fall 1967).

Analysis of hot-channel factors for the Shippingport Atomic Power Station, PWR Core 1 and Core 2, is presented. The changes needed in the kinds of hot-channel factors and the methods of calculating and using hot-channel factors with core thermal-design techniques over the past ten years are described. Increased understanding of boiling flow has permitted relaxation of thermal limitations which has changed the emphasis on the various hot-channel factors. The results of these developments have contributed to the overall technical effort that more than double core power level and density. (auth)

22728 DUNGENESS B: MEMBRANE MOVES IN. Engineering, 205: 440-2(Mar. 22, 1968).

Progress on the AGR power station is reported. Details are given of the construction of the membrane (pressure vessel liner) and boilers. (UK)

22729 THE PROGRESS OF FAST REACTOR DEVELOPMENT IN THE UNITED KINGDOM. Frame, A. G.; Cope, L. H. (United Kingdom Atomic Energy Authority, Risley, Eng.). BNX Rev., No. 2, 13-16(Nov. 1967).

The contribution of experience with the DFR to the present status of development is discussed, and progress with the PFR is summarized. The main parameters of the PFR and of a 1000 MW(e) commercial fast reactor design are listed. (UK)

22730 OPTIMISATION OF AGR FUEL CYCLE COSTS. Bamford, F. W.; Johnson, A. (United Kingdom Atomic Energy Authority, Risley, Eng.). BNX Rev., No. 2, 7-12(Nov. 1967).

The scope for variations in the cost of the various components of the total fuel cycle is examined, and the interaction between the various stages of reactor operation and fuel production and processing is discussed. The effect of scale of operation is also discussed. The role of the supplier of fuel services in connection with the optimisation of the total fuel cycle is indicated, and it is suggested that there is considerable scope for collaboration and joint planning between the fuel service supplier and the reactor operator. (UK)

22731 STATUS REPORT ON FUEL BURN-UP PREDICTIONS IN THERMAL REACTORS IN CZECHOSLOVAKIA. Kujal, B. (Nuclear Research Inst., Rez, Czech.). pp 29-33 of Fuel Burn-up Predictions in Thermal Reactors. Vienna, International Atomic Energy Agency, 1968.

From IAEA Meeting on Fuel Burnup Predictions in Thermal Reactors, Vienna, Austria. See STI/PUB-172; CONF-670418.

Methods and codes used for burn-up calculation in thermal heavy-water reactors are described. Some results for heavy-water gas or organic cooled reactors are presented. The influence of the uncertainty of fundamental data on final results is discussed. (auth)

22732 THE BEHAVIOUR OF FUELS IN THERMAL REACTORS: STUDIES CARRIED OUT BY THE COMMISSARIAT A L'ENERGIE ATOMIQUE. Cogne, F. (Centre d'Etudes Nucleaires, Saclay, France). pp 35-63 of Fuel Burn-up Predictions in Thermal Reactors. Vienna, International Atomic Energy Agency, 1968. (In French).

From IAEA Meeting on Fuel Burnup Predictions in Thermal Reactors, Vienna, Austria. See STI/PUB-172; CONF-670418.

Since 1958, the Commissariat à l énergie atomique has carried out a series of theoretical and experimental studies to extend knowledge of the nature of radioactivity changes in natural or slightly enriched uranium fuel reactors, so as to be able to forecast fuel burn-up with the greatest possible accuracy and thus determine the economics of this type of reactor. The first theoretical studies were devoted to the development of a synthetic model of neutron thermalization, to provide a very accurate picture of the neutron spectrum in the thermal range and to permit calculation of the heavy nuclei cross-sections as often as may be necessary to follow changes in the isotopic composition. Other theoretical studies included the rigorous treatment of fission products (to reflect reactivity changes more faithfully), spot calculations of reactivity changes, and the calculation of reactor flux and power distributions, variations in temperature coefficients, and reactor kinetics. Experimental studies made on actual power reactors included measurements of over-all changes in reactivity and temperature coefficients, and measurements of power distributions. These measurements, which are needed for reactor operation, cannot very well be transposed to other reactors, so that experiments of a more analytical nature have to be carried out to determine the change in the isotopic composition of fuels (irradiated fuel analyses) and to relate this to the change in reactivity, by systematic studies of the physics of plutonium fuel, e.g., critical experiments on homogeneous uranium-plutonium fuels by the gradual replacement method and by the oscillation method, using fuels irradiated by means of oscillation. (auth)

22733 FUEL BURN-UP PREDICTIONS IN THERMAL REACTORS: A REVIEW OF RECENT WORK IN THE UNITED STATES OF AMERICA. Spinrad, B. I. (Argonne National Lab., Ill.). pp 65-80 of Fuel Burn-up Predictions in Thermal Reactors. Vienna, International Atomic Energy Agency, 1968.

From IAEA Meeting on Fuel Burnup Predictions in Thermal Reactors, Vienna, Austria. See STI/PUB-172; CONF-670418.

Work in the United States of America on fuel burn-up predictions in thermal reactors is very varied, since each reactor designer has some choice of emphasis. Thus, some consider very precise prediction to be their aim, and others are satisfied with less precision, to be supplemented by reactor operating experience. Major work has been in progress for some time at Pacific Northwest Laboratories (formerly Hanford) on plutonium recycle and value problems; at Combustion Engineering and Savannah River Laboratories on D_2O reactors; at General Electric, Argonne and Combustion Engineering on boiling reactors; at Westinghouse, and Babcock and Wilcox, on pressurized reactors; and many other sites. Quite detailed calculation has been the rule for PWRs. The Shippingsport reactor is dominated by its enriched seed, and the techniques required for predicting its behavior are the multi-group, multi-region methods developed for research reactor analysis. Reactivity behavior has thereby been predicted to some precision (K_{eff} known to better than 1% throughout life), power shape to better than 5% for high flux zones, and plutonium production to about 5%. Other PWRs have been predicted by methods closer to standard lattice theory, giving power shapes better than 10% for high flux zones, production and burn-up to about 5%, and a correlation of production and burn-up to within experimental error. BWRs are dominated by the boiling process. Indeed, a combination of hydrodynamic calculations and reactor physics theory is required, with the former being the less precise. The achievement of criticality at a given power is therefore primarily a measure of void distribution. Perhaps because this constrains all theories to $K_{eff} = 1$, the predictions of burn-up and production behavior are no less precise than for PWRs. Similar experience is reported on other reactor types. There seem to be no outstanding problems except those of im-

proving precision without entailing unusually complex computing methods. A persistent difficulty is that both bulk analysis of spent fuel and critical experimentation produce analytical errors that are large enough to make it uncertain whether small discrepancies are, in fact, of theoretical origin. (auth)

22734 DETERMINATION OF THE POWER DENSITY DISTRIBUTION IN THE CORE OF THE BWR POWER STATION AT GARIGLIANO. Colling, A.; Nacfaire, H. (EURATOM, Brussels). pp 81-8 of Fuel Burn-up Predictions in Thermal Reactors, Vienna, International Atomic Energy Agency, 1968. (In French).

From IAEA Meeting on Fuel Burnup Predictions in Thermal Reactors, Vienna, Austria. See STI/PUB-172; CONF-670418.

Methods of determining power density used for the core of the BWR power station at Garigliano are described. The results were obtained from a research program performed by ENEL and the General Electric Company under the Euratom-United States of America co-operation agreement. The means employed consist essentially of: (1) Internal instrumentation: ionization chambers and irradiation wires; (2) Special instrumentation to measure the total gamma activity and that of the 2.55-MeV gamma ray of ^{140}La. The measurements were performed on the fuel elements of a complex octant of the core during the scheduled shut-down in November 1965; (3) A GE412 "on-line" computer using a simplified code to determine the power density distribution and the irradiation rates of the fuel elements. Comparison of the results obtained makes it possible to assign a value of 0.023 to the standard deviation between the calculated and measured values for the gamma activity of ^{140}La for power density distributions. (auth)

22735 BURN-UP PREDICTION IN THERMAL REACTORS IN JAPAN. Mochizuki, K. (Japan Atomic Energy Research Inst., Tokyo); Tachibana, A. pp 89-107 of Fuel Burn-up Predictions in Thermal Reactors, Vienna, International Atomic Energy Agency, 1968.

From IAEA Meeting on Fuel Burnup Predictions in Thermal Reactors, Vienna, Austria. See STI/PUB-172; CONF-670418.

Several codes developed by many organizations in Japan, related to cell burn-up, flux synthesis, hetero- and homogeneous methods, and fuel management, are introduced and reviewed briefly. Modification of the codes originally developed in other countries, and some evaluation of spectrum models, cross-sections and decay chains are presented also. Emphasis has been put on the need for accurate simulators to predict fuel burn-up, and a few simulators and codes have been checked with power reactor operation data with reasonable accuracy. Some tests and experiments have been conducted in two operating power reactors in connection with burn-up problems. Comment is made on chemical analysis, beta and mass spectrometries on irradiated fuels. Preliminary studies of non-destructive fuel burn-up tests at a light-water critical assembly are described, and comments are given on regular exchange of technical information and other problems involved in fuel burn-up. (auth)

22736 METHODS FOR FUEL BURN-UP PREDICTION USED IN SWEDEN. Ahlstrom, P.-E. (State Power Board, Stockholm); Blomberg, P. E. pp 127-46 of Fuel Burn-up Predictions in Thermal Reactors, Vienna, International Atomic Energy Agency, 1968.

From IAEA Meeting on Fuel Burnup Predictions in Thermal Reactors, Vienna, Austria. See STI/PUB-172; CONF-670418.

The Swedish calculational methods for burn-up physics are briefly described, containing both recipes for survey calculations and more complex few-group schemes. Most of the development work has been directed to the heavy-water reactor system but later activities also include methods applicable to light-water systems. The various sources of basic nuclear data used in the calculations are accounted for and briefly considered in relation to the differences obtained. Some of the calculational methods are compared with the experimental information obtained from the Ågesta, NPD and YANKEE power reactors, and from the well-known NRX-slugs. A survey of experimental methods being used in Sweden for burn-up studies is given. These include reactivity, power distribution and flux-fine structure measurements in the Ågesta power reactor, and also experiments for determining burn-up level, isotopic composition, effective cross-section changes and effective neutron yield changes in irradiated fuel samples. (auth)

22737 BURN-UP ANALYSIS OF LARGE BOILING-WATER REACTORS. Crowther, R. L. (General Electric Co., San Jose, Calif.). pp 173-89 of Fuel Burn-up Predictions in Thermal Reactors, Vienna, International Atomic Energy Agency, 1968.

From IAEA Meeting on Fuel Burnup Predictions in Thermal Reactors, Vienna, Austria. See STI/PUB-172; CONF-670418.

Large boiling-water reactor power stations such as Dresden introduce new problems in burn-up analysis. Analysis problems increase exponentially with reactor size, both because a greater number of points is required to describe the system and because numerical difficulties arise as a result of the loose coupling. A number of new iterative methods have been developed to help to solve large core problems. These methods involve non-eigenvalue solutions by use of the power-control method and calculation of consistent power-exposure shapes at the time of refueling either by a transformation to exposure space or a direct few-group power-exposure iterative method. For cases in which detailed history-dependent effects are small, calculation of consistent power-exposure states at the end of each fuel cycle interval provides a rapid method to determine three-dimensional burn-up distribution in partial batch refuelled reactors. The consistent power-exposure shape also provides a good target to guide operation of the reactor. Design considerations such as requirements for tandem refuelling or fuel reinsert make fuel burn-up predictions more difficult. Optimization problems also complicate the task and increase the incentive for fast methods. One-group coarse mesh methods have been used extensively to determine power distributions for large BWRs. Comparison of these methods with measured data indicates agreement to within approximately ±10%. The on-line computer will play an increasing role in burn-up analysis of BWRs. A new interpretative class of methods is required for on-line analysis. (auth)

22738 REVIEW OF BURN-UP PHYSICS WORK WITH THE HALDEN HEAVY BOILING-WATER REACTOR. Lunde, J. E. (Institutt for Atomenergi, Halden, Norway). pp 203-11 of Fuel Burn-up Predictions in Thermal Reactors. Vienna, International Atomic Energy Agency, 1968.

From IAEA Meeting on Fuel Burnup Predictions in Thermal Reactors, Vienna, Austria. See STI/PUB-172; CONF-670418.

A burn-up physics experimental program has been undertaken with the second fuel charge of HBWR to verify the validity of physics calculational methods. At the end of operation in December 1966, the fuel charge had an estimated average burn-up of 6200 MWd/tU with a maximum exposure in excess of 10,000 MWd/tU. Experiments already conducted or in progress are: Isotopic composition measurements of irradiated fuel; pile oscillator measurements of irradiated fuel; neutron-yield measurements of irradiated fuel; spectral indices measurements in the irradiated lattice; critical size measurements as a function of moderator temperature in the irradiated core; temperature reactivity coefficient measurements as a function of moderator temperature in the irradiated core; power void reactivity measurements as a function of nuclear power in the irradiated core. A theoretical development program, necessary for relevant interpretations of these experiments, has been carried out. The Halden Project has developed the burn-up part of a multigroup collision probability lattice computer program in a co-operative action with AB Atomenergi, Sweden. (auth)

22739 THREE-DIMENSIONAL FUEL BURN-UP CALCULATIONS IN WWER REACTORS. Novikov, A. N.; Petrunin, D. M.; Belyaeva, E. D.; Ionov, V. S.; Shabalov, A. I.; Romanov, B. A. (Kurchatov Inst. of Atomic Energy, Moscow). pp 213-26 of Fuel Burn-up Predictions in Thermal Reactors. Vienna, International Atomic Energy Agency, 1968.

From IAEA Meeting on Fuel Burnup Predictions in Thermal Reactors, Vienna, Austria. See STI/PUB-172; CONF-670418.

Power-reactor operation involves frequent fuel changes, and the economics of the power station depend largely on the correct carrying out of this procedure. As a result, it is necessary to prepare special calculational programs for selecting reloading schedules, and preliminary analysis of the reactor operating conditions must be carried out. During the design and construction of the Novo-Voronezh atomic power station various two-dimensional and three-dimensional programs were prepared for the purpose of analyzing the physical and thermal characteristics of the WWER reactor in use at this power station, calculating the efficiency and critical positions of the control rods, determining the heat-release and temperature graphs, calculating fuel burn-up, etc. Taking as an example the most usual assignment—fuel burn-up calculation—the method of solution adopted in the programs is discussed and its accuracy analyzed. The calculated results are compared with data from critical experiments and from operation of the reactor at the Novo-Voronezh power station. (auth)

22740 SENSITIVITY OF FAST REACTOR ECONOMICS TO UNCERTAINTIES IN NUCLEAR DATA. Greebler, P.; Hutchins, B. A.; Linford, R. B. (General Electric Co., Sunnyvale, Calif.). Nucl. Appl., 4: 297-306(May, 1968).

The uncertainties in physics parameters and in fuel cost of fast power reactors due to current nuclear data uncertainties are considered for two sodium-cooled, oxide-fueled, 1000 MW(e)

reactors. One reactor has a low core neutron leakage and a core composition that results in very low fuel cost and short doubling time for fissile material. The second reactor is forced to satisfy stringent safety criteria associated with the sodium voiding reactivity problem and, hence, has a high core neutron leakage and a large amount of moderating material (BeO) in its core composition, with resultant higher fuel cost. Ranges in uncertainties in fuel cost and doubling time for each recognized significant data uncertainty over a "correlated" energy interval are evaluated, using the highest and the lowest reasonable values of that nuclear data parameter, as well as the values recommended in the Brookhaven Evaluated Nuclear Data Files (ENDF/B). On the basis of the calculated sensitivity of fuel cost to specific data uncertainties, a set of targets for nuclear data accuracy that would reduce the calculated fuel cost uncertainty to about ±.03 mill/kWh is recommended. 29 references. (auth)

22741 22nd ANNUAL ISA CONFERENCE PROCEEDINGS, VOL. 22, 1967. PART IV. APPLICATIONS IN INDUSTRY AND SCIENCE. Conference held in Chicago, September 11–14, 1967. Pittsburgh, Instrument Society of America, 1967. 277p. (CONF-670903–(Pt.4)).

Included are thirty papers on control systems, instruments, and safety devices for laboratory equipment and nuclear reactors. Separate abstracts are presented for four of the papers. Two papers were previously abstracted and appear in the report number index under CONF-670903. (D.C.C.)

For abstracts of individual papers see: 21394, 22110, 22742, and 22743.

22742 COMPUTER ANALYSIS TO DETECT REACTOR MALFUNCTIONS. Volk, E. R.; Nims, J. B. (Atomic Power Development Associates, Inc., Detroit). Annu. ISA (Instrum. Soc. Amer.) Conf. Proc., 22: 30.1.NID.67.1-12(1967).

From 22nd Instrument-Automation Conference and Exhibit, Chicago. See CONF-670903–(Pt.4).

The early detection of malfunctions in nuclear reactors is both a safety and economic necessity. Up to the present time, the actual or planned use of real-time process computers on reactors has been primarily in the areas of fuel management, data acquisition, and checking of sensor values for maximum or minimum limits. Based upon a recent incident of fuel melting in the Enrico Fermi Atomic Power Plant, it is now believed that by properly utilizing several sensor signals and by performing calculations to predict expected results, an additional degree of malfunction detection can be realized. Since the proposed methods apply during all operating conditions, the ability to detect failures at low power levels is possible, thus reducing and perhaps eliminating the damage and associated repair or replacement costs. The equipment proposed for the Enrico Fermi Malfunction Detection System is reviewed, along with the basis of its selection. (auth)

22743 NUCLEAR PLANT PROTECTIVE SYSTEMS: SAFETY WITH RELIABILITY. Nathan, A. (Sargent and Lundy, Chicago). Annu. ISA (Instrum. Soc. Amer.) Conf. Proc., 22: 43.3.PID.67.1-12(1967).

From 22nd Instrument-Automation Conference and Exhibit, Chicago. See CONF-670903–(Pt.4).

Commercial nuclear power plants require a relatively large and complex system of protective and control equipment. Stress must therefore be placed on simplicity without compromising reliability in designing the nuclear plant instrumentation and control system. The nuclear plant protective system monitors reactor and plant systems variables and must detect and identify abnormal conditions. This protective system must in addition, rapidly take action to reduce plant power, limiting any temperature or power transient to safe values. Nuclear power plant instrumentation and control designing efforts must constantly emphasize and consider its important relationship with the plant protective system. A plant protective system can only be as reliable and responsive as the basic nuclear power plant instrumentation and control system will permit. (auth)

22744 NUCLEAR SAFETY. Volume 9, Number 3. Cottrell, Wm. B.; Jordan, W. H.; Blakely, J. P.; Savolainen, A. W. (eds.). One of Four Technical Progress Reviews Published for the Division of Technical Information, USAEC. Oak Ridge, Tenn., Oak Ridge National Lab., May-June 1968. 107p. GPO $0.60.

Separate abstracts are prepared for each of the eleven sections. Information is included on: problems and progress in nuclear facilities licensing, general safety criteria, accident analysis, control and instrumentation, plant safety features, consequences of activity release, operating experience, nuclear safety research and development projects, AEC administrative activities, action on reactor and other projects undergoing regulatory review, and changes in licensing regulations. (M.L.S.)

For abstracts of individual sections see: 22745–22755.

22745 PROBLEMS AND PROGRESS IN NUCLEAR FACILITIES LICENSING. Mitchell, William. Nucl. Safety, 9: 193-201(May-June 1968).

From its creation in 1954, the AEC program for licensing major nuclear facilities has undergone a gradual, and somewhat uneven, evolution. Old problems have recurred and new ones have arisen. Since 1962, various studies by the Joint Congressional Committee on Atomic Energy, by AEC consultants, and by the AEC itself have resulted to some degree in simplifying and expediting the process. Vigorous and imaginative efforts will be necessary to adapt the program to the tremendous increase in nuclear power construction now taking place. 27 references. (auth)

22746 FAST REACTOR SAFETY CONFERENCE. MacPherson, R. E. Nucl. Safety, 9: 202-9(May-June 1968).

Aix-en-Provence, France, was the location of an International Conference on the Safety of Fast Reactors in September 1967. The Commissariat à l'Énergie Atomique sponsored a well-organized meeting that drew 340 participants from 18 countries. Three international organizations were represented. Sixty-four papers were presented covering various aspects of reactor operating experience, advanced fast reactor safety problems, liquid-metal boiling and superheating, and pertinent core physics considerations. A panel discussion involving representatives from Belgium, Euratom, Germany, Great Britain, France, and the United States examined the current status of world opinion on fast reactor safety; and the conference was concluded with a tour of the Cadarache facilities devoted to fast reactor research and development. (auth)

22747 REVIEW OF NUCLEAR SAFETY EXPERIMENTS ON FAST REACTOR CORE BEHAVIOR. Dickerman, C. E. (Argonne National Lab., Ill.). Nucl. Safety, 9: 210-17(May-June 1968).

An experimental investigation was made on the behavior during accidents of sodium-bonded metallic fuel pins. Models were developed to describe failure of metallic fuel pins (EBR-II, Mark I) in both flowing and stagnant sodium environments, although the prefailure axial movement of molten fuel cannot be described quantitatively. The first investigations of postfailure movement of coolant and fuel were performed with clusters of fuel pins. Although large-scale secondary movements were demonstrated in TREAT, much more work is necessary to characterize them properly, including determining effects of blankets, larger clusters, and propagation phenomena. 37 references. (auth)

22748 CONFERENCE ON INCIPIENT FAILURE DIAGNOSIS FOR ASSURING SAFETY AND AVAILABILITY OF NUCLEAR POWER PLANTS. Walker, C. S. Nucl. Safety, 9: 218-25(May-June 1968).

A conference on the possible contribution of incipient failure detection to the safety and reliability of nuclear power plants was held in Gatlinburg, Tenn., Oct. 30–Nov. 1, 1967. Participants were from the fields of reactor instrumentation, nuclear plant design, nuclear plant operation, nondestructive testing, and disciplines outside the nuclear field. The papers and discussions covered the topics of on-line testing, methodology of testing, symptomatic examination of reactor core behavior, methods to detect incipient failures in reactor primary systems, methods to detect incipient failures in nonnuclear applications, and histories of reactor incidents. On-line techniques for testing reactor protection instrument systems have been developed and, in some instances, applied. Various acoustical methods give promise of detecting incipient failures in vessels, pipes, and mechanical operating equipment, such as pumps. (auth)

22749 IODINE DEPOSITION AND ITS ENHANCEMENT UNDER REACTOR ACCIDENT CONDITIONS. Genco, J. M.; Rosenberg, H. S.; Morrison, D. L. (Battelle Memorial Inst., Columbus, Ohio). Nucl. Safety, 9: 226-38(May-June 1968).

The current status of fundamental iodine deposition studies at the Columbus Laboratories of Battelle Memorial Institute is summarized. Deposition experiments were conducted on primary- and containment-system surfaces, and it was found that HI exhibits considerably greater deposition than I_2 on primary surfaces, especially at elevated temperatures. Thermodynamic and kinetic data on several typical containment-vessel paints indicated considerable iodine penetration into the interior of the coatings. A diffusion with chemical-reaction mechanism can adequately explain the data. Effort has been directed to the development of a reactive coating system capable of enhancing iodine deposition under serious reactor accident conditions. 96 references. (auth)

22750 WASTE MANAGEMENT AT NUCLEAR POWER STATIONS. Blomeke, J. O.; Harrington, F. E. Nucl. Safety, 9: 239-48(May-June 1968).

The management of wastes produced at nuclear power plants may become an increasingly significant problem in an economy that is expected to grow to 50 times its present size within the next 13 years. As a preliminary step in assessing future implications, reviews were made of the operating experience in waste management at the arbitrarily selected Dresden 1, Big Rock Point, Humboldt Bay, Elk River, Indian Point 1, and Yankee power stations. All nuclear power stations, including those named above, have operated well within the limits authorized for release of radioactive wastes to the environment. The maximum annual average releases of activity and noble gases have ranged from 0.0026% of the limit at Indian Point to as much as 28% of the limit at Humboldt Bay. On the basis of an allowable continuous discharge of activity at an average concentration of 10^{-6} $\mu c/cm^3$, the releases in liquid wastes have ranged from as little as 0.0002% of the limit at Elk River during a 12-month period in 1962–1963 to as much as 9.9% of the limit at Big Rock Point in 1966–1967. The concentration of tritium in the wastes has not been routinely determined in the past, but recent analyses give evidence that 5 to 20 curies has been released annually at each of the boiling-water-reactor stations, and about 500 and 1300 curies have been discharged annually at Indian Point and Yankee, respectively. In all cases, tritium has been released at much less than 1% of its limit. It is concluded that waste-management practices at light-water power-reactor stations have been quite adequate in the past, and that there are no future problems anticipated in this area that will not be resolved in the normal course of an expanding industrial technology. 20 references. (auth)

22751 SAFETY-RELATED OCCURRENCES IN REACTOR AND RADIOACTIVITY: HANDLING OPERATIONS AS REPORTED IN 1966. Cramer, E. N. Nucl. Safety, 9: 249-67(May-June 1968).

One hundred and thirty occurrences that were reported in 1966 had particular safety-related significance and are categorized as happening in production and utilization facilities or in radioisotope production or usage. A brief description is given of each occurrence, together with principles of operation and/or design that might have prevented such occurrences. 13 references. (auth)

22752 PROGRESS SUMMARY OF NUCLEAR SAFETY RESEARCH AND DEVELOPMENT PROJECTS. Savolainen, A. W.; Whetsel, H. B. (comps. and eds.). Nucl. Safety, 9: 268-82 (May-June 1968).

A summary of efforts in the area of nuclear safety research and development is given. The following areas on water reactor safety are discussed: reactor kinetics and related studies; integrity of primary systems; loss of coolant and containment response; fission product behavior under accident conditions; multipurpose projects; safety-test experiment program (LOFT); in-plant testing; and criteria, codes, standards, and specifications. 31 references. (M.L.S.)

22753 AEC ADMINISTRATIVE ACTIVITIES. Blakely, J. P. (comp.). Nucl. Safety, 9: 282-6(May-June 1968).

A general breakdown of the proposed FY 69 budget for the AEC is given. The 1968 ACRS committee is listed. JCAE comments on regulation, and safety and siting are presented. (M.L.S.)

22754 ACTION ON REACTOR AND OTHER PROJECTS UNDERGOING REGULATORY REVIEW OR CONSIDERATION. Blakely, J. P. (comp.). Nucl. Safety, 9: 286-97(May-June 1968).

AEC regulatory action on the following projects is summarized: Big Rock Point (Docket 50–155), Calvert Cliffs 1 and 2 (Dockets 50–317 and 50–318) Cook 1 and 2 (Dockets 50–315 and 50–316), Diablo Canyon (Docket 50–275), LaCrosse (Docket 115–2), Midwest Fuel-Recovery Plant (Docket 50–268), Nine Mile Point (Docket 50–220), Ocouee 1, 2, and 3 (Dockets 50–269, 50–270, 50–287), Peach Bottom 2 and 3 (Dockets 50–277 and 50–278), Piqua (Docket 115–2), Salem 1 and 2 (Dockets 50–272 and 50–311), Three Mile Island (Docket 50–289), Vermont Yankee (Docket 50–271), VESR (Docket 50–183), and Yankee (Docket 50–29). 26 references. (M.L.S.)

22755 CHANGES IN LICENSING REGULATIONS. Blakely, J. P. (comp.). Nucl. Safety, 9: 297-300(May-June 1968).

Proposed changes in reactor licensing regulations are tabulated. Proposed rule changes as of Feb. 1, 1968 in 10 CFR are: Parts 1, 2, 50, 115, 20, 25, 26, 95, 30, 40, 70, 170, 31, and 32. Comments on the record keeping changes proposed (10 CFR, Part 20) are given. (M.L.S.)

22756 PROCEEDINGS OF THE INSTRUMENT SOCIETY OF AMERICA TENTH NATIONAL POWER INSTRUMENTATION SYMPOSIUM, DALLAS, TEXAS, MAY 8–10, 1967. VOLUME 10. Pittsburgh, Instrument Society of America, 1967. 208p. (CONF-670547).

Included are 15 papers on the instrumentation, control, and automation of electric power stations. Separate abstracts were prepared for two papers dealing with instrumentation and control systems for nuclear plants. (H.D.R.)

For abstracts of individual papers see: 22757 and 22758.

22757 INSTRUMENTATION AND CONTROL SYSTEM DESIGN FEATURES OF THE SAN ONOFRE NUCLEAR GENERATING STATION. Savitch, Charles S. (Southern California Edison Co., Los Angeles); Matsumoto, Toshio; Schmauss, William F. ISA (Instrum. Soc. Amer.), Proc., Nat. Power Instrum. Symp., 10: 25-39(1967).

From 10th National ISA Power Instrumentation Symposium, Dallas. See CONF-670547.

Some of the basic design philosophies and operating practices which led to the features incorporated in the San Onofre instrumentation and control system are discussed. (H.D.R.)

22758 CONTROL OF BOILING WATER REACTOR: POWER/WATER PLANTS. Crever, F. E.; Maxwell, D. C. (General Electric Co., San Jose, Calif.). ISA (Instrum. Soc. Amer.), Proc., Nat. Power Instrum. Symp., 10: 189-96(1967).

From 10th National ISA Power Instrumentation Symposium, Dallas. See CONF-670547.

The results of a study of the control characteristics and requirements of a boiling water reactor, back pressure turbine, and multistage flash plant are presented. The study was made using a digital computer to solve in the time domain the system of equations representing the dynamic response of the dual purpose plant. (auth)

22759 THE PHYSICS PROBLEMS IN THERMAL REACTOR DESIGN. Proceedings of an International Conference, London, June 27–29, 1967. London, British Nuclear Energy Society, 1967. 336p. £ 5. (CONF-670607).

The 41 presented papers relate to the physics of uniform and non-uniform lattices, the physics of operating reactors, Pu build-up, and fuel management. A record of the presentation and discussion of the papers is included. Separate abstracts were prepared for 39 of the papers. Abstracts have been previously included in NSA for 2 papers, which can be found under CONF-670607 in the report number index. (UK)

For abstracts of individual papers see: 22760–22781, 22831–22842, and 22868–22872.

22760 EXPERIMENTAL STUDIES OF UO_2–H_2O LATTICES OF UNIFORMLY ARRAYED RODS AND CLUSTERED ELEMENTS. Wajima, J. T.; Kobayashi, S.; Yamamoto, H.; Kikuchi, H.; Ohnishi, T.; Matsuoka, K.; Yamamoto, K. (Hitachi, Ltd., Tokyo). pp 67-72 of The Physics Problems in Thermal Reactor Design. London, British Nuclear Energy Society, 1967.

From International Conference on Physics Problems of Thermal Reactor Design, London. See CONF-670607.

Lattice studies of uniformly arrayed UO_2 rods and of clustered elements of a nuclear superheat reactor were performed and analyzed. Microparameters were measured and multiplication factors for the four-factor formula with ^{235}U epithermal fissions were obtained. Empirical formulae for microparameters were derived, and a method of measuring the nonleakage probability is presented. The analysis of the lattice of the clustered fuel element is discussed. (auth)

22761 EXPERIMENTS AND CALCULATIONS FOR DENSELY LOADED SLIGHTLY ENRICHED UO_2-FUELLED CORES. Plumlee, K. E.; Pennington, E. M. (Argonne National Lab., Ill.). pp 73-5 of The Physics Problems in Thermal Reactor Design. London, British Nuclear Energy Society, 1967.

From International Conference on Physics Problems of Thermal Reactor Design, London. See CONF-670607.

Critical experiments and calculations for 3% and 5% enriched UO_2-fueled H_2O-moderated cores indicate that reasonably accurate calculational techniques are available, using certain modifications, for core loadings as low as one-to-one in $H/^{235}U$ atom ratio. Such cores have capabilities for high power density, high conversion ratio, and long core lifetime. (auth)

22762 FINE STRUCTURE IN UNIRRADIATED AGR LATTICES. Mossop, I. A. (United Kingdom Atomic Energy Authority, Windscale, Eng.); Rowbotham, J. R.; Collinson, B.; Undrill, P. E.; Bridge, M. J. pp 152-5 of The Physics Problems in Thermal Reactor Design. London, British Nuclear Energy Society, 1967.

From International Conference on Physics Problems of Thermal Reactor Design, London. See CONF-670607.

The most important fine structure parameters for design and operation purposes are ring-ring variations, pin-pin variations within each ring, and hyperfine variations across individual pins. Also of importance are the effects on these parameters of axial discontinuities in the fuel clusters. Methods currently used to predict these parameters for both uniform and nonuniform lattices are outlined, and specific comparisons with experiment for typical two- and three-ring clusters are presented. UO_2 and PuO_2/UO_2 fuel results are given for both room and elevated temperature conditions. Predictions can be made of ring-ring ratios to within 1½% for uniform enrichment, and pin-pin ratios within 3% for multiple enrichment clusters. Flux variations around a channel wall due to cross channel gradients can be predicted to within 1%; within the cluster the agreement is less good, depending on the accuracy of cross pin gradient predictions, which is at worst 6%. The calculation of mean can/mean fuel flux is adequate for design purposes (~1½%). Predictions of flux rises in regions of axial fuel gaps can be made within 6% over a wide range of gap widths. (auth)

22763 EXPERIMENTAL EVALUATION OF THE VALIDITY OF THE DESCRIPTION OF THREE-DIMENSIONAL POWER AND VOID DISTRIBUTIONS FOR BWR'S USING THE FLARE MODEL COUPLED WITH JPHYDRO. Shimooke, T.; Mochizuki, K. (Japan Atomic Energy Research Inst., Tokyo). pp 162-7 of The Physics Problems in Thermal Reactor Design. London, British Nuclear Energy Society, 1967.

From International Conference on Physics Problems of Thermal Reactor Design, London. See CONF-670607.

The validity of the FLARE model to describe BWR core performance was investigated experimentally in comparison with data accumulated up to 3000 MWd/t burn-up. A set of parameters can be determined without any contradiction to the wide range of operating data. According to the calculational result by FLARE it is possible to obtain such agreement that, for example, error in eigenvalue is less than ±0.4% and the gross peaking factor would not exceed FLARE calculations by more than 5%. It can be considered that the FLARE model is useful for the design, evaluation and simulation of BWRs with reasonable accuracy, provided that it is used in combination with other tools for calculation of the inputs. (auth)

22764 EXPERIMENTAL FLUX DISTRIBUTIONS IN EL 4 AND COMPARISON WITH THREE-DIMENSIONAL HETEROGENEOUS CALCULATIONS. Chabrillac, M.; Gatel, R.; Naudet, R. (CEN, Saclay, France). pp 168-71 of The Physics Problems in Thermal Reactor Design. London, British Nuclear Energy Society, 1967.

From International Conference on Physics Problems of Thermal Reactor Design, London. See CONF-670607.

Start-up experiments were performed in the EL 4 reactor. The initial fuel loading of this reactor is non-uniform. A triheterogeneous code was developed in order to analyze flux and power distributions during operation. The flux-charts measured at different stages of the zero power experiments provided a good opportunity to test the calculations. (auth)

22765 EVALUATION OF LATTICE PARAMETERS FOR A HEAVY WATER MODERATED, NATURAL URANIUM FUELLED POWER REACTOR. Accinni, F.; Bonalumi, R.; Ciuffolotti, L.; Mangialajo, M.; Palazzi, F.; Taddei, F.; Zorzoli, G. B. (Centro Informazione Studi Esperienze, Segrate, Italy). pp 172-7 of The Physics Problems in Thermal Reactor Design. London, British Nuclear Energy Society, 1967.

From International Conference on Physics Problems of Thermal Reactor Design, London. See CONF-670607.

The experimental reactor physics work performed in connection with the design of a natural uranium fueled, fog cooled, and heavy water moderated power reactor is described. Integral measurements by substitution method and detailed cell measurements on a subcritical facility were performed. The measurement techniques, the results and their accuracy are discussed, and a comparison with calculated data are described. A special experimental procedure, named "single cell experiment," is also described. "Ad hoc" experiments are detailed and discussed. (auth)

22766 REBUS–HETERO; A SCHEME FOR REACTOR PHYSICS AND BURN UP CALCULATIONS. COMPARISON WITH EXPERIMENTS AND APPLICATION TO THE AGESTA REACTOR. Ahlstrom, P.-E. (Swedish State Power Board, Stockholm); Apelqvist, G.; Blomberg, P.; Skardhamar, T. pp 193-200 of The Physics Problems in Thermal Reactor Design. London, British Nuclear Energy Society, 1967.

From International Conference on Physics Problems of Thermal Reactor Design, London. See CONF-670607.

More than 250 experimental bucklings were compared with results obtained by the standard code used in Sweden for calculating lattice parameters and burn-up in heavy water moderated reactors (REBUS). The overall agreement is good, but REBUS results must be used with care when certain differential effects are studied. A reasonable agreement is also obtained with experiments concerning burn-up. The application to macroscopic systems is exemplified by the use of REBUS and the heterogeneous programme HETERO on the Agesta Power Reactor. The reactivity history during the first three operating years is calculated both for cores without control rods and for cores with observed control rod positions. The calculated reactivities are compared to the experimental results, which were evaluated from observed control rod positions. As the ^{235}U fission rate closely follows the thermal neutron flux, a direct comparison between calculated fluxes and measured fission rates in a fuel cluster, is possible. The agreement is, for most purposes, satisfactory. (auth)

22767 DOUGLAS POINT PHYSICS MEASUREMENTS. Brenciaglia, G. (Hydro Electric Power Commission, Ontario, Can.). pp 201-3 of The Physics Problems in Thermal Reactor Design. London, British Nuclear Energy Society, 1967.

From International Conference on Physics Problems of Thermal Reactor Design, London. See CONF-670607.

A preliminary report is given of the startup measurements made in Douglas Point. A comparison of predictions and experimental results is made, and a brief review of the calculations used is given. (auth)

22768 THE PHYSICS OF NON-UNIFORM BWR LATTICES. Aline, P. G.; Barth, N. H.; Clancey, W. R.; Crowther, R. L.; Fischer, D. L.; Hallam, J. W.; Weitzberg, A.; Warzek, F. G.; Wall, I. B. (General Electric Co., Cincinnati). pp 208-17 of The Physics Problems in Thermal Reactor Design. London, British Nuclear Energy Society, 1967.

From International Conference on Physics Problems of Thermal Reactor Design, London. See CONF-670607.

BWR critical experiment and power reactor measurements carried out since 1957 are summarized, along with theoretical-experimental comparisons. Some unexplained discrepancies of physics interest are apparent. Space dependent differential measurements made in clumped lattices are an important basis for nuclear model verification. The importance and effects of space dependent neutron spectra in clumped lattices are emphasized. (auth)

22769 PHYSICS DEVELOPMENT FOR PLUTONIUM UTILISATION IN PRESSURISED WATER REACTORS. Orr, W. L.; Langford, F. L.; Leamer, R. D. (Westinghouse Atomic Power Divisions, Pittsburgh). pp 218-25 of The Physics Problems in Thermal Reactor Design. London, British Nuclear Energy Society, 1967.

From International Conference on Physics Problems of Thermal Reactor Design, London. See CONF-670607.

Analytical results are compared with measurements made on Pu-containing uniform and non-uniform lattices, and during power operation in the Saxton Reactor, which contains a partial core of Pu-fueled assemblies. (UK)

22770 THE STUDY OF THE LATTICE PARAMETERS AND ENERGY RELEASE CONTROL IN THE BELOYARSK ATOMIC POWER PLANT REACTOR. Vaymugin, A. A.; Dubovskii, B. G.; Evseev, A. Ya.; Kisil, I. M.; Konstantinov, L. V.; Lyubtchenko, V. F.; Minashin, M. E.; Postinkov, V. V.; Snitko, E. I.; Sharapov, V. N. pp 226-8 of The Physics Problems in Thermal Reactor Design. London, British Nuclear Energy Society, 1967.

From International Conference on Physics Problems of Thermal Reactor Design, London. See CONF-670607.

The lattice of this reactor includes fuel channels of complex geometry and various enrichments, and a large number of absorbing rods comprising the control and safety system. In the course of designing the reactor, detailed investigations were made of lattice data, reactivity, and flux distributions, together with studies of the effect of local lattice non-uniformities on the flux in adjacent fuel channels. In operation, the reactor power distribution is monitored by measurements of the relative effectiveness of control rods. In determining channel powers, allowance must be made for the effects of differences between fuel channels, and the presence of control and safety rods, vacant channels and other non-uniformities. The study of lattice parameters and local flux perturbations was carried out in a central test region of a uranium-graphite experimental reactor, the size of test region being chosen to be sufficient to give a representative neutron spectrum. Further data were obtained during commissioning of the BAPP reactor; these results were in satisfactory agreement with those obtained by the test region technique. (auth)

22771 EVALUATION OF FUEL DEPLETION AND PLUTONIUM BUILDUP IN THE YANKEE POWER REACTOR. McGaugh, J. D.; Lacey, P. G.; Nodvik, R. J.; Radcliffe, R. E. (Westinghouse Electric Corp., Pittsburgh). pp 249-54 of The Physics Problems in Thermal Reactor Design. London, British Nuclear Energy Society, 1967.

From International Conference on Physics Problems of Thermal Reactor Design, London. See CONF-670607.

The relations between reactivity changes and total energy generation and Pu buildup and U depletion are discussed. The results of 320 analyses of depleted fuel pellets removed from 253 core locations were employed. One fuel assembly which had been irradiated in three core cycles was examined and provided data corresponding to a peak burnup of 46,000 MWd/tU. The agreement between prediction and measurement was, in general, entirely satisfactory. (UK)

22772 ANALYSIS OF IRRADIATED FUEL FROM HEAVY WATER AND GRAPHITE REACTORS. Cogne, F. (CEN, Saclay, France). pp 255-61 of The Physics Problems in Thermal Reactor Design. London, British Nuclear Energy Society, 1967.

From International Conference on Physics Problems of Thermal Reactor Design, London. See CONF-670607.

The results of 110 measurements on irradiated fuels, either in heavy water lattices (30 measurements), or in graphite reactors, are presented. After a brief résumé of the methods used for isotopic change calculations, and also of the methods of analysis and their accuracy, the irradiations performed are described. The results of the analyses are given and compared with theory. Burn-up conditions for all the analyzed irradiated fuels are given. (auth)

22773 AN INVESTIGATION OF LONG TERM REACTIVITY CHANGES IN MAGNOX REACTORS. Butterfield, J. M.; Richardson, L. A. (Central Electricity Generating Board, Berkeley, Eng.). pp 264-73 of The Physics Problems in Thermal Reactor Design. London, British Nuclear Energy Society, 1967.

From International Conference on Physics Problems of Thermal Reactor Design, London. See CONF-670607.

Work being undertaken to establish limits on fuel irradiation set by reactivity requirements is described. Existing experimental and theoretical information on reactivity changes is reviewed, and the measured reactivity build-up in a Calder Reactor, which provides the best currently available experimental data, is used to test methods of predicting reactivity changes. One such method uses the ARGOSY lattice code to calculate reactivity changes at a point in a reactor, and the point data are combined to give channel and whole reactor reactivity changes by means of statistical weighting and the CRAM reactor code. An attempt is made to assess the accuracy of reactivity predictions based on ARGOSY, and a possible use of the calculations is illustrated by applying them to determine the reactivity build-up of a channel of fuel if the fuel elements are axially shuffled during irradiation. (auth)

22774 THE MEASUREMENT OF IRRADIATION DEPENDENT CHARACTERISTICS OF AGR FUEL. Mossop, I. A.; Owen, T. D. (United Kingdom Atomic Energy Authority, Windscale, Eng.). pp 274-7 of The Physics Problems in Thermal Reactor Design. London, British Nuclear Energy Society, 1967.

From International Conference on Physics Problems of Thermal Reactor Design, London. See CONF-670607.

The design of cluster type fuel should be chosen so as to compromise between fine structure conditions existing at low and high burnup, so that optimum performance with respect to gas flow and heat transfer characteristics is obtained. Measurements of radial and axial fine flux distributions in unirradiated fuel can be made with foil techniques in sub-critical stacks, but for irradiated fuel, a technique known as Gamma Scanning has been developed. The technique employs the activity of a short half life fission product to measure the terminal rating of the fuel, and that of a long half-life product to measure integrated fission or burnup. Fuel pins from different radial positions in the clusters are traversed individually past a collimating slit and the gamma energies from the chosen fission products are detected by a gamma spectrometer. Results are given for radial and axial rating distributions in a typical WAGR experimental fuel, with burnup up to about 15000 MWd/t. Due to the increased burnup of ^{235}U in regions of higher flux, which is not completely balanced by enhanced ^{239}Pu production, the ring-to-ring rating ratio and the axial rating peaking decrease with irradiation. A heavy isotope analysis on pellets from the end of a fuel pin irradiated to about 14000 MWd/t supported the latter conclusion. The same pellets were analyzed radiochemically for $^{144}Ce/Pr$ for comparison with gamma scanning estimates of the Ce/Pr distribution; very good agreement was obtained. (auth)

22775 BURNUP AND POWER DISTRIBUTION FOR LIGHT WATER MODERATED PLUTONIUM FUELLED CLUSTERS. Loizzo, P.; Buffoni, G.; Lopez, S.; Michelini, M. (CNEN, Rome). pp 278-80 of The Physics Problems in Thermal Reactor Design. London, British Nuclear Energy Society, 1967.

From International Conference on Physics Problems of Thermal Reactor Design, London. See CONF-670607.

Fuel clusters in water reactors are generally separated by water gaps, control rod followers, etc, which cause the occurrence of local peak factors. The problems are increased by the recycling of plutonium, and a "novel" effect is added: the interference of the already existing UO_2 elements with the harder spectrum plutonium-fueled clusters. A review of the problem arising with this kind of cluster is made; typical PWRs and BWRs are considered, and calculations are made to optimize the local Pu concentrations in the fuel elements. A two dimensional-two group scheme (BURNY) is used. A new nuclear model is proposed (two dimensional-two thermal group) to allow for the more complicated fission rate behavior in Pu clusters. Comparison is made with THERMOS results and experiments. Further confirmations are needed by comparison with experiments. (auth)

22776 TECHNICAL ASPECTS OF THE FUEL CYCLES OF THE THREE ENEL NUCLEAR POWER STATIONS. Sani, L. (ENEL, Rome). pp 287-96 of The Physics Problems in Thermal Reactor Design. London, British Nuclear Energy Society, 1967.

From International Conference on Physics Problems of Thermal Reactor Design, London. See CONF-670607.

The results of studies on the technical problems associated with the fuel cycles of the three Italian nuclear power stations are considered, particularly in the light of the operational limits imposed by working conditions and their effects on the choice of a fuel cycle. After definition of the fuel management criteria adopted, a comparison of the various solutions is made. (auth)

22777 FUEL MANAGEMENT AND ISOTOPIC COMPOSITION PREDICTION AND EXPERIMENT IN LIGHT WATER POWER REACTORS. Aline, P. G.; Brugge, R. O.; Clancey, W. R.; Crowther, R. L.; Fischer, D. L.; Ruiz, C. P.; West, D. L. (General Electric Co., San Jose, Calif.). pp 297-305 of The Physics Problems in Thermal Reactor Design. London, British Nuclear Energy Society, 1967.

From International Conference on Physics Problems of Thermal Reactor Design, London. See CONF-670607.

BWR fuel management and isotopic composition experiments, and their correlation with nuclear calculations are summarized. It is concluded that present models for isotopic composition calculation are slightly conservative, with discrepancies attributed to uncertainties in nuclear data and difficiencies in the description of multigroup space-energy interactions. Global power distributions are calculated to within approximately ±8%. (auth)

22778 FUEL MANAGEMENT STUDIES FOR AGRs. Billington, D. E.; Buckler, A. N.; Criggs, C. F.; Scrogg, C. (United Kingdom Atomic Energy Authority, Risley, Eng.). pp 306-11 of The Physics Problems in Thermal Reactor Design. London, British Nuclear Energy Society, 1967.

From International Conference on Physics Problems of Thermal Reactor Design, London. See CONF-670607.

In common with other thermal reactors the power distribution in an Advanced Gas-Cooled Reactor is sensitive to the composition of the core. Thus considerable care must be taken in the management of the fuel in the core if high power output is to be obtained without violating metallurgical restrictions placed on the fuel. Methods of calculation developed for the study of AGR fuel cycles at two levels of complexity are described. In the first method detail is sacrificed to achieve a rapid method suitable for use in identifying promising cycles. The second method is then used to study the detailed management of the chosen cycles. Results are presented for typical AGR situations. (auth)

22779 FUEL CYCLES FOR ADVANCED GAS COOLED REACTORS. Beynon, A. J.; Clarke, R. H.; Linder, C.; Nunn, R. M.; Roberts, J. E. B.; Thornton, D. L. (Central Electricity Generating Board, Berkeley, Eng.). pp 312-17 of The Physics Problems in Thermal Reactor Design. London, British Nuclear Energy Society, 1967.

From International Conference on Physics Problems of Thermal Reactor Design, London. See CONF-670607.

The CEGB AGRs will be refueled on load. With this facility the cheapest fuel cycle is the equilibrium cycle, where fuel is discharged at a constant rate, and at constant irradiation. Studies of the most economic method of proceeding from the initial unirradiated fuel charge to the equilibrium condition without exceeding either the irradiation or peak power limits of the fuel are summarized. The simple just-critical fuel cycle is described, and im-

provements to it are discussed. It is found that the improvements can reduce the total fuel bill for an AGR station by about £2 million. The actual choice of fuel cycle still awaits lengthy calculations of fuel can temperatures and internal gas pressures. One of the economically attractive fuel cycles discussed requires the use of burnable poisons, and suitable burnable poisons are described. (auth)

22780 FUEL MANAGEMENT STUDIES FOR EL 4. Naudet, R. (CEN, Saclay, France). pp 320-2 of The Physics Problems in Thermal Reactor Design. London, British Nuclear Energy Society, 1967.

From International Conference on Physics Problems of Thermal Reactor Design, London. See CONF-670607.

EL 4 is a horizontal pressure tube, gas cooled, heavy water moderated reactor. Refueling is made on power according to the bi-directional push-through technique. Several computer codes have been developed for the study of fuel management in this reactor. Initial fueling raises some difficult problems, and careful consideration has been devoted to the definition of the first loading. The most advanced code, TRICYCLE 3, based on tridimensional heterogeneous calculations, gives a detailed simulation of the reactor operation from the burn-up standpoint. (auth)

22781 FUEL MANAGEMENT IN SGHW REACTORS. Briggs, A. J.; Hicks, D.; Hopkins, D. R. (Atomic Energy Establishment, Winfrith, Eng.). pp 323-30 of The Physics Problems in Thermal Reactor Design. London, British Nuclear Energy Society, 1967.

From International Conference on Physics Problems of Thermal Reactor Design, London. See CONF-670607.

The methods used for fuel management calculations are briefly reviewed. Checks were made against burn-up data from other water-moderated reactor systems and against the results from a special zero energy experimental programme which included Pu-bearing fuels. It is believed that the conclusions reached on expected power reactor performance are soundly based. (auth)

22782 INSTRUMENTATION FOR ORGANIC COOLED REACTOR. Cliffe, W. W. (to Canadian General Electric Co. Ltd.). Canadian Patent 778,116. Feb. 13, 1968.

To measure the pressure of mixed terphenyl coolants in a nuclear reactor which are viscous at room temperature, a pressure transmitting device is described. Hydrogenated terphenyl which is chemically and physically compatible with the organic coolants and which remains liquid both at the working range and room temperature, is used as a pressure transmitting fluid. The instrument is connected to the coolant flow tube by a pressure transmission pipe which is then filled with the low viscosity hydrogenated terphenyl. Provision is made for injecting additional transmission fluid into the pressure transmission pipe for flow into the more viscous coolant whereby ingress of the latter into the transmission pipe is limited. Thus the pressure transmitting capability is maintained. The sensor is designed to show the coolant pressure up to 500 lb/in.^{2}, its temperature is 500 to 800°F. (F.S.A.)

22783 DEVICE FOR A NUCLEAR REACTOR. Imanishi, Atsuo (to Fuji Electric Mfg. Co., Ltd.). Japanese Patent 1966-18761. Oct. 29, 1066. Filed Aug. 17, 1963.

In the graphite-moderated, CO_2 gas-cooled, power reactor, the temperature of CO_2 gas cannot be very high because of the limitation imposed by nuclear fuel. When this heated gas is used as the medium to heat secondary coolant for generating steam, the pressure of the latter cannot become sufficiently high to operate the turbines efficiently. In the proposed device for a nuclear reactor, this problem is dealt with by using a separate heater different from the reactor itself. The secondary coolant system is divided in three sub-systems in the heat exchanger with primary gas coolant: in the first two sub-systems coolant water is boiled and the produced steam is then superheated at their respective pressure; and in the third sub-system pressurized coolant water takes away the heat remaining from the other two sub-systems. The two kinds of superheated steam, and the heated coolant water are taken into a separate heater (heat exchanger), which is operated by other heating medium than the nuclear one. After leaving the heater, sufficiently high pressure vapor is led to the turbines. If desirable, the first sub-system, or both the first and second sub-systems may be partly or wholly closed, to operate the third sub-system alone. (NSA of Japan)

22784 GERMETICHESKIE VODYANYE NASOSY ATOMNYKH ENERGETICHESKIKH USTANOVOK. (Hermetically Sealed Water Pumps in Nuclear Power Plant Installations). Sinev, N. M.; Udovichenko, P. M. Moscow, Atomizdat, 1967. 375p.

In view of the wide use of water as reactor coolant, canned pumps have been developed to satisfy a great variety of demands, with discharge rates ranging from a few m^3/hour to several m^3/hour, operating pressures up to 300 atmospheres and water temperatures up to 350°C. The leaktight electric motors used for these pumps have power ratings within the 1 to 2000kW range. Many scientific and engineering problems must be overcome in the design of the electric and pumping portions of these systems. Successful construction of these units made it possible to incorporate them into the primary circuits of many water-cooled, water-moderated, graphite-water, heavy-water and boiling water reactors. They are also used for the cooling systems of ship propulsion reactors and for large research reactors, with heavy or light water as coolant or moderator. Constructional solutions for the elements of canned pumps are analyzed, reviewing both the Soviet and non-Soviet literature. (TTT)

22785 UNDERGROUND MINING REACTOR, APPARATUS, AND METHOD. Schlicht, G. R. A. O.; Lange, H. (to Deutsche Erdol-Aktiengesellschaft). Canadian Patent 771,279. Nov. 7, 1967. Priority date Mar. 29, 1962, Germany.

Equipment is described for combined thermal and radiation treatment of liquid bitumens which may contain reactor poisons. A power reactor surrounded by a reflector and having a heat exchanger above is adapted to be lowered into a boring in bituminous strata. There is also a radiation reactor adjacent adapted to contain radioactive substances with connecting conduits to the power reactor. At least 500 m underground is a "decay container" where fuels or solutions from the reactor may be stored for later recovery at the surface of the ground. Catalysts and other substances may be added to the bitumen stream to promote desirable reactions. Graphite or water may be used as a moderator and water or polyphenyl as coolants. Particle fuel in suspension is suggested. Control is achieved by a gas cushion at the top of the reactor chamber which receives the fuel elements temporarily during overheating. (F.S.A.)

22786 METHOD AND APPARATUS FOR INCREASING THE CRITICAL HEAT FLUX FOR HIGH PRESSURE STEAM/WATER FLOW IN NUCLEAR REACTORS. Wikhammer, G. A.; MacDonald, I. P. L.; Collier, J. G. (to Atomic Energy of Canada Ltd.). Canadian Patent 774,693. Dec. 26, 1967.

The inside surface of the pressure tubes containing the nuclear fuel contain "roughness" rings spaced between 1.50 in. to 4.50 in. apart. These rings extend inward from the smooth inside surface of the fuel channel from 0.015 in. to 0.050 in. Prevention of "dry-out" and consequent improvement in critical heat flux by a factor up to 5 is believed to result from turbulent flow induced by the rings and the absence of instability or roll waves between the fuel bundle and the pressure tube wall. Parameters in an experimental apparatus are given. (F.S.A.)

Marine and Portable Power Reactors

22787 (ORNL-4216) TERRESTRIAL LOW-POWER REACTOR PROGRAM. Quarterly Progress Report for Period Ending September 30, 1967. (Oak Ridge National Lab., Tenn.). Mar. 1968. Contract W-7405-eng-26. 42p. Dep. CFSTI.

ARMY REACTORS (PM-3)—description of PM-3A
ARMY REACTORS—description of Army Standard Plant conceptual design; flow diagram for conceptual 1.5 MW(e) Terrestrial Low-Power; containment system for conceptual 1.5 MW(e), description of
INDIAN POINT POWER REACTOR, UNIT 2—description of
REACTORS, BOILING—description of .1 MW(e) water-cooled; description of 1.5 MW(e) water-cooled
REACTOR CONTROL SYSTEMS—description of .1 MW(e) boiling, (T)
REACTOR SIMULATORS—control system for .1 MW(e) boiling
TURBINES—description of availability of small high-speed hermetically sealed steam
REACTOR CONTAINMENT SYSTEMS—description of Army 1.5 MW(e), conceptual (D.C.C.)

Rocket and Space Reactors

Refer also to abstract 21267.

22788 (CONF-661204-(Vol.2), pp 78,1-11) MULTIPLE EXHAUST NOZZLES FOR ADVANCED NUCLEAR ROCKET ENGINES. Duke, E. E.; Vanica, D. F. (Aerojet-General Corp., Sacramento, Calif.).

Although the aerodynamic efficiency of the multiple nozzle design is lower than an equivalent single nozzle because of flow impingement shock losses, the concept does offer a significant

advantage in payload capability when applied to advanced nuclear rockets. Analytical procedures for nozzle shape design and theoretical performance predictions were developed and an experimental program was conducted to provide data which would substantiate the analytical procedures. Results of theoretical and experimental studies conducted to evaluate and compare the performance of nuclear rockets employing multiple exhaust nozzles to expand reactor exhaust gases are briefly presented. Results indicate that nozzle convective cooling requirements are reduced by using refractory nozzle materials so that less pump work is required, hence less turbine bleed flow is required, which makes more propellant available for thrust conversion at higher Isp. Also, less heat is extracted from the exhaust gases because of the reduced cooling requirements. The most significant advantages were found to be the performance gains which occur when the overall engine length is shortened and exhaust temperatures increased permitting a greater potential propellant capacity and specific impulse respectively. (auth)

22789 (CONF-661204-(Vol.2), pp 80.1-11) TURBOPUMP CONFIGURATION SELECTION FOR AN OPTIMIZED NUCLEAR ENGINE. Campbell, William E. (Aerojet-General Corp., Sacramento, Calif.).

The approach to the configuration selection of the turbopump for a typical large hot bleed cycle nulcear engine is presented. The performance of the reference engine used was: 5000 MW power; 245,000 lb thrust; 625 psia chamber pressure; 4500°R chamber temperature; and 0 psi pump net positive suction pressure. The five basic configurations tested were: centrifugal pump with three-stage overhung turbine; multi-stage straddled axial pump with three-stage overhung turbine; centrifugal pump with seven-stage straddled turbine; multi-stage straddled axial pump with seven stage straddled turbine; and two-stage centrifugal pump with three-stage overhung turbine. Parametric and mechanical design studies to maximize the performance and minimize weight and length were completed. (D.C.C.)

22790 (CONF-661204-(Vol.2), pp 91.1-12) STATUS OF NUCLEAR PROPULSION FOR SPACE FLIGHT. Beveridge, J. H. (Aerojet-General Corp., Sacramento, Calif.).

A description of NERVA program components developed by Aerojet is presented. The components include: the nozzle and associated hot gas bleed port for the turbine drive fluid; the turbopump; the turbine power control valve; the pressure vessel; and the nozzle mounted hot gas thermocouples. (D.C.C.)

22791 (GA-8309) THERMIONIC CRITICAL EXPERIMENT PROGRAM. Cohen, S. C. (Gulf General Atomic, Inc., San Diego, Calif.). Nov. 28, 1967. Contract AT(04-3)-167. 50p. Dep. CFSTI.

An examination of the unique features of a generic thermionic space power reactor and the related neutronic uncertainties and design problems are described. The overall objective of the critical experiment program is to compare integral neutronic data from a number of assemblies with detailed neutronic calculations in order to check analytical methods and cross section data used in the core design of thermionic space power reactors. This will be accomplished by constructing five categories of critical assemblies from the very simple in composition and configuration to the complex, culminating in a program of engineering mockup experiments. (auth)

Process Heat and Desalination Reactors

Refer also to abstract 22758.

22792 (BNL-12319) POLLUTION-FREE HYBRID FOSSIL-NUCLEAR FUELED MHD POWER CYCLE. Steinberg, M.; Powell, J. R.; Beller, M.; Manowitz, B. (Brookhaven National Lab., Upton, N. Y.). [1968]. 51p. (CONF-660837-1). Dep. CFSTI.

From Conference on International Energy Conversion Engineering, Denver, Colo.

A hybrid power plant is developed based on a hydrogen–oxygen combustion MHD cycle. Hydrogen is generated by reforming fossil fuel with nuclear generated steam and oxygen is obtained from air in an air separation plant. Steam is injected into the combustion gases to control temperature and pressure through the duct. A preliminary parametric study of the cycle efficiency and MHD characteristics is made with steam and helium as diluent. Overall thermal efficiencies of 55% appear practical with nuclear energy contributing 38% and coal 62% to the power cycle. Preliminary design capital investment, production cost, and breakeven fuel cost estimates are presented. The hybrid system offers a number of technical and economic advantages. It allows the use of fossil fuel in a pollution-free plant; conventional water and gas-cooled nuclear reactors can be utilized in an MHD cycle; thermal pollution is significantly decreased; a clean MHD duct is provided. The preliminary evaluation indicates that the system allows fossil fuel to compete with nuclear energy in high fossil fuel cost areas and conversely, it allows nuclear energy to compete in low fossil fuel cost areas, thus expanding the market for both fuel sources. 13 references. (auth)

22793 (NP-17404) FEASIBILITY STUDY OF A DUAL-PURPOSE NUCLEAR PLANT AND THE USE OF TWO DESALINATION PROCESSES (FLASH EVAPORATOR AND ELECTRODIALYSIS). Pollis, W.; Baptista, L. Donadio; Grimberg, M. (Comissao Nacional de Energia Nuclear de Brasil, Rio de Janeiro). Aug. 1965. 20p. Dep.

The engineering and economic feasibility of a dual-purpose power-desalination reactor is examined. Electricity, produced in hours of off-peak demand would be used to treat brackish water in an electrodialysis installation. This treated water, still in a brackish state, would be mixed with pure water from a flash evaporation plant to produce potable water. Several variations of plant factors and economic conditions are presented. (H.D.R.)

22794 (NP-17405) SOCIAL-ECONOMICAL METHOD OF CALCULATING THE WATER DESALINATION COST THROUGH DUAL-PURPOSE NUCLEAR PLANTS IN REGIONS WHERE ELECTRIC POWER IS OBTAINED AT HIGH COSTS. Pollis, W.; Baptista, L. Donadio; Grimberg, M. ([Comissao Nacional de Energia Nuclear de Brasil, Rio de Janeiro]). Jan. 1966. 11p. Dep.

A method to determine the cost balance for supplying electric power and water from a dual-purpose nuclear plant in areas of high electric power cost is presented. The method considers the social and economic conditions that exist in the plant area, and establishes a cost for the electric power near the present cost. The resulting water cost is then estimated. (H.D.R.)

22795 (NP-17406) FEASIBILITIES OF NUCLEAR REACTORS FOR WATER DESALINATION OF THE SEA WATER AND ELECTRIC POWER PRODUCTION IN FORTALEZA, BRAZIL. Pollis, W.; Baptista, L. Donadio; Grimberg, M. ([Comissao Nacional de Energia Nuclear de Brasil, Rio de Janeiro]). Aug. 1965. 18p. Dep.

The economics of employing a dual-purpose power-desalination reactor in the area near Fortaleza, Brazil are examined. The plant considered would produce 150 MW(e) and 300,000 cubic meters of water per day. (H.D.R.)

22796 NUCLEAR ENERGY FOR INDUSTRIAL HEAT AND POWER. Decker, G. L. (Dow Chemical Co., Midland, Mich.); Wilson, W. B.; Bigge, W. B. Chem. Eng. Progr., 64: No. 3, 61-8 (Mar. 1968).

Modern industrial process plants require large amounts of process steam and electric power. The logic and economics associated with the use of nuclear energy for large process plants is examined by comparisons between large fossil and nuclear units. The large nuclear plants are found to compare favorably in unit steam and power costs and in total operating costs, but the requirement for an annual shutdown for refueling a reactor needs to be evaluated in the over-all economics. (H.D.R.)

Research and Test Reactors and Critical Assemblies

Refer also to abstracts 21329 and 21674.

22797 (AAEC/M-13) REACTOR HIFAR: THE MAIN HEAVY WATER PUMP CIRCUITS (S1). Page, G. (Australian Atomic Energy Commission Research Establishment, Lucas Heights). Jan. 1968. 9p. plus Charts. Dep.

A manual which describes the operation of the relay circuitry associated with the control of the main heavy water pumps for the HIFAR reactor is presented. (auth)

22798 (AAEC/M-23) REACTOR HIFAR: THE TRIP AND WARNING ALARM CIRCUITS. Page, G. (Australian Atomic Energy Commission Research Establishment, Lucas Heights). Oct. 1967. 8p. plus Chart. Dep.

A manual which describes the operation of the Trip and Warning Alarm circuits in HIFAR and their relation to other parts of the safety circuits is presented. (auth)

22799 (AHSB(S)Handbook-5(Pt.1)) HANDBOOK OF EXPERIMENTAL CRITICALITY DATA. PART I. Chapters 1 to 4. Abbey, F. (comp.) (United Kingdom Atomic Energy Authority, Risley (England). Authority Health and Safety Branch). 1967. 122p. Dep. CFSTI. UK.

Criticality data from the literature are compiled into tabulated form. These tables are broken down into: single unmoderated ^{235}U cores; single unmoderated plutonium cores; single ^{235}U cores moderated by deuterium, beryllium, or carbon; and single plutonium cores moderated by deuterium, beryllium, or carbon. Data are given various geometric configurations. 67 references. (M.L.S.)

22800 (BNWL-575) APPLICATIONS OF GEOMETRIC MODELS FOR THE FFTF HYDRAULIC CORE MOCKUP. Trent, D. S. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). Nov. 1967. Contract AT(45-1)-1830. 127p. Dep. CFSTI.

The model analysis of the Hydraulic Core Mockup which would provide analytical criteria for model design and experiment is described. The analysis was carried out by defining requirements for attaining adequate physical similarity of the FFTF hydraulic core concerning hydraulics, mechanics and certain thermal aspects. The results are summarized. (auth)

22801 (BNWL-651(Vol. 1 and 2)) COMPUTER PROGRAMS FOR OPERATION OF THE HIGH TEMPERATURE LATTICE TEST REACTOR (HTLTR). Coffin, L. D.; Simmons, S. J.; Kosorok, J. R.; Haines, C. E.; Roberts, W. C. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). Dec. 1967. Contract AT(45-1)-1830. 633p. Dep. CFSTI.

A digital computer has been interfaced with a reactor measurement and control system. Descriptions are given for all the computer programs which are an integral part of that system and which allow the operation of the reactor and associated equipment. Program functions, detailed coding descriptions and listings are included. In addition, program integration and techniques for updating the system are described. (auth)

22802 (BNWL-661) PRELIMINARY RELIABILITY ANALYSIS FOR FFTF SAFETY CIRCUITS. Monteith, Oscar B. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). Mar. 1968. Contract AT(45-1)-1830. 29p. Dep. CFSTI.

A preliminary reliability prediction for the Fast Flux Test Facility Reactor Safety System is reported. The system is analyzed for two failure modes; failures that cause spurious responses (reactor scrams), and failures that result in the inability to respond to unsafe conditions. Results are preliminary because the system is a conceptual version and components have not been specified. (auth)

22803 (BNWL-667) CORRELATION OF RADIATION DAMAGE TO MATERIALS FOR FFTF. Russcher, G. E.; Dahl, R. E. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). Mar. 1968. Contract AT(45-1)-1830. 15p. Dep. CFSTI.

Radiation damage processes which may be critical to FFTF structural materials are the production of high temperature crystal lattice defects such as vacancy clusters or micro voids, extended defects, He production by fast neutron (n,α) reactions with matrix elements, and He generation in steel by slower neutron (n,α) interactions with boron. Though high temperature radiation damage appears related to production of voids or extended defects, current correlation techniques are based on equating gross displacement defect production in various neutron spectra. Computer simulation of lattice behavior during irradiation and annealing is being used to develop improved correlation techniques. He generation in Ni alloys and stainless steel leads to embrittlement and loss of ductility. Current correlation is based on gross He production. However, agglomerated He atoms probably affect mechanical properties more than the same number of atoms distributed uniformly through the material. Computer simulation of He migration and agglomeration is aimed at providing an improved correlation basis for the effect of He production. 15 references. (auth)

22804 (BNWL-685) REACTOR PHYSICS DEPARTMENT TECHNICAL ACTIVITIES QUARTERLY REPORT, OCTOBER, NOVEMBER, DECEMBER 1967. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). Mar. 1968. Contract AT(45-1)-1830. 108p. Dep. CFSTI.

NEUTRONS—scattering low model for, short time approximation for evaluating Egelstaff-Schofield; resonance absorption in multiregion unit cells, use of Nordheim's integration methods for; flux measurements in PCTR, use of foil activation techniques for; flux calculations for FTR split core

PLUTONIUM RECYCLE TEST REACTOR—core for, interim critical tests on Batch; fuel elements for, reactivity worth measurements for; fuel elements in, effects on reactivity of plutonium variation in; temperature coefficient of reactivity measurements in

EXPERIMENTAL BOILING WATER REACTOR—fuel elements for, burnup data from gamma scanning of

PLUTONIUM RECYCLE CRITICAL FACILITY—safety system for, reactivity worths of; core for, description of critical mockup of MTR-Phoenix fueled; control rods for Phoenix-fueled, calibration of; temperature coefficient of reactivity measurements in Phoenix-fueled, reactivity worth; void reactivity worth measurements in Phoenix-fueled

PHYSICAL CONSTANTS TESTING REACTOR—core variations for, description of, neutron flux; measurements in; neutron multiplication measurements in, use of uranium-lithium supercell for

CRITICAL ASSEMBLIES—critical mass measurements in the Critical Approach Facility; neutron buckling measurements in the Critical Approach Facility; control rod reactivity worth measurements in the Critical Approach Facility; neutron spectrum measurements in heterogeneous plutonium fueled, integral

FOILS—neutron flux measurements in PCTR using activation

REACTOR CONTROL ELEMENTS—calibration of PCRF-Phoenix core; reactivity worth measurements for FTR, analysis of

REACTIVITY—measurement of temperature coefficient of, PCRF-Phoenix core; work measurements of FTR control elements, analysis of

HIGH TEMPERATURE LATTICE TEST REACTOR—startup experiments in, analysis of; measurement and control system for, description of programmed; startup of, use of on-line digital computer for; oscillators for, description of

COMPUTERS—startup of HTLTR using on-line digital

NEUTRONS, THERMAL—flux profiles around uranium-lithium supercell in PCTR; scattering and dynamics in heavy water, inelastic; scattering in water, inelastic

SODIUM—coolant for FTR, reactivity worth calculations for

FAST TEST REACTOR—core for, neutronics calculations for split; neutron noise in, feedback effects on; control rods for, analysis of reactivity worth measurements for

NEUTRON CROSS SECTION—group constants for FTR calculation

FAST FLUX TEST FACILITY—shielding for, material composition of

SHIELDING—composition of FFTF; thicknesses of FFTF blast

NOZZLES—shielding requirements for FFTF cover

CRITICALITY STUDIES—critical measurements using plutonium nitrate in slab geometry

WATER-d_2—neutron inelastic scattering and dynamics in, thermal

WATER—neutron inelastic scattering in, thermal

REACTOR OSCILLATORS—description of HTLTR (M.L.S.)

22805 (BNWL-711) DECONTAMINATION OF THE PLUTONIUM RECYCLE TEST REACTOR (PRTR) PRIMARY SYSTEM. Weed, Ronald D. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). Mar. 1968. Contract AT(45-1)-1830. 28p. Dep. CFSTI.

An improved decontamination process consisting of alkaline permanganate followed by an inhibited oxalic-citrate mixture was used. The decontaminating solutions effectively removed more than 31 Ci of radioactivity with an effective primary system decontamination factor of 24. Corrosion of carbon steel and stainless steels during the decontamination process and development data for decontamination process are discussed. (auth)

22806 (CEA-R-3131(Vol.1)) RAPPORT DE SURETE DE "MELUSINE" (APRES AUGMENTATION DE PUISSANCE A 4 MW). PARTIE DESCRIPTIVE. TOME I. (Safety Report Concerning MELUSINE (after Power Increase to 4 MW). Descriptive Part. Volume I). Baas, Christian, Delcroix, Victor; Jacquemain, Michel; Marouby, Roger; Meunier, Claude; de Robien, Emmanuel, Rossillon, Francois (Commissariat a l'Energie Atomique, Grenoble (France). Centre d'Etudes Nucleaires). Mar. 1967. 222p. (In French). Dep.

A brief description of the site of the MELUSINE reactor is given. Detailed descriptions and diagrams of the reactor and control systems are included. Design parameters are tabulated. (M.L.S.)

22807 (CEA-R-3131(Vol.2)) RAPPORT DE SURETE DE "MELUSINE" (APRES AUGMENTATION DE PUISSANCE A 4 MW). PARTIE DESCRIPTIVE. TOME II. (Safety Report Concerning MELUSINE (after Power Increase to 4 MW). Descriptive Part. Volume II). Baas, Christian, Delcroix, Victor; Jacquemain, Michel; Marouby, Roger; Meunier, Claude; de Robien, Emmanuel, Rossillon, Francois (Commissariat a l'Energie Atomique, Grenoble (France). Centre d'Etudes Nucleaires). Mar. 1967. 83p. (In French). Dep.

Detailed descriptions and diagrams of the buildings for the Melusine reactor are given. Ventilation systems and electrical systems are described. Detailed descriptions of the experimental facilities and hot cells are given. Procedures for resin handling are outlined. Pool activity calculations are shown; results of thermal calculations and measurements are given. A calculation of effects of hypothetical pump stoppage is given. (M.L.S.)

22808 (CEA-R-3323) SYSTEME DE PILOTAGE AUTOMATIQUE DU REACTEUR PEGGY. (Automatic Control System for the Reactor Peggy). Bertrand, Jean; Mourchon, Robert; Da-Costa, David; Desandre-Navarre, Christian (Commissariat a l'Energie Atomique, Cadarache (France). Centre d'Etudes Nucleaires). Dec. 1967. 50p. (In French). Dep.

The equipment makes it possible for the reactor to attain a given power automatically and for the power to be maintained around this level. The principle of its operation consists in the changing from one power to another, at constant period, by means of a programmer transforming a power-step request into a voltage variation which is linear with time and which represents the logarithm of the required power. The real power is compared continuously with the required power. Stabilization occurs automatically as soon as the difference between the reactor power and the required power diminishes to a few per cent. (auth)

22809 (CEA-R-3328) DETECTION DE RUPTURE DE GAINE DU REACTEUR OSIRIS. (Can Rupture Detection for the Reactor Osiris). Douet, Paul; Graftieaux, Jean (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires). Dec. 1967. 56p. (In French). Dep.

The can rupture detection installation for the reactor Osiris is discussed in two parts. The first part gives the calculations which were carried out during the designing of the installation for estimating its performances. The second part is an account of the tests carried out for calibrating the installation after the first power-run of the reactor. The measured sensitivity and detection threshold (16 counts/sec. for 1 cm^2 of U_{nat} and 2 cm^2 of U_{nat}) are fairly close to the calculated values (12 counts/sec. for 1 cm^2 U_{nat} and 1 to 2 cm^2 U_{nat}). (auth)

22810 (DP-995) IRRADIATION OF TUBULAR UO_2 FUEL ELEMENTS IN THE HWCTR. Crim, T. H.; Cole, G. R.; Holmes, W. G. (Du Pont de Nemours (E. I.) and Co., Aiken, S. C. Savannah River Lab.). Nov. 1967. Contract AT(07-2)-1. 78p. Dep. CFSTI.

Irradiation of 97 Zircaloy-clad urania tubes in the Heavy Water Components Test Reactor indicated that tubes with compacted powder cores made by the best available techniques will operate satisfactorily in a full scale heavy-water-moderated power reactor to peak exposures of at least 20,000 MWD/MTU and peak thermal ratings ($\int_{T_0}^{T_c} kd\theta$) of 30 watts/cm. Examination of 45 tubes irradiated in the HWCTR indicated that: less than 10% of the fission gas produced during irradiation was released in fuel tubes operating at low $\int kd\theta$; the fractional release increased sharply with the onset of columnar grain growth in the urania core; release of nitrogen from impurities in fused urania was substantially reduced by outgassing the urania at high temperature in vacuum or hydrogen before irradiation; the outer sheath wrinkled in tubes with relatively low-density cores [82 to 87% of theoretical density (TD)] operated at $\int kd\theta$ of 40 to 45 watts/cm; and tubes compacted to 90% TD did not wrinkle when irradiated at 50 watts/cm. (auth)

22811 (EUR-3650) IRRADIATION EXPERIMENTS IN THE HFR AND THE LABORATORIES OF THE RESEARCH ESTABLISHMENT OF EURATOM AND THE REACTOR CENTRUM NEDERLAND AT PETTEN: A SURVEY OF POSSIBILITIES. Bugl, J.; Rottger, H. (European Atomic Energy Community, Petten (Netherlands). Joint Nuclear Research Center). May 1967. 63p. Dep.

A description of HFR reactor is presented. The description includes: the reactor itself; irradiation facilities; hot cells; post-irradiation analysis devices; and operation economics. (D.C.C.)

22812 (EUR-3881) FORCED CONVECTION BURNOUT AND HYDRODYNAMIC INSTABILITY EXPERIMENTS FOR WATER AT HIGH PRESSURE. PART IV. BURNOUT EXPERIMENTS IN A DOUBLE CHANNEL TEST SECTION WITH TRANSVERSELY VARYING HEAT GENERATION. Campanile, A.; Galimi, G.; Goffi, M. (Societa Ricerche Impianti Nucleari, Saluggia (Italy). Centro Ricerche Nucleari). Dec. 12, 1967. 35p. Dep.

Experiments have been carried out on a complex geometry test section consisting of two heating rods coaxially mounted in two adjacent and communicating flow channels. Several conditions of differential heating in the two channels were tested to the aim of investigating the effect on burnout limits of possible variations of local flow velocity and fluid enthalpy due to transverse flow redistribution and mixing. (auth)

22813 (EUR-3886) PROBLEMES THERMIQUES LIES A UN CANAL DE ZIRCALOY A AILETTES DANS UN REACTEUR ORGEL. (Thermal Problems Inherent in a Finned Zircaloy Channel in an ORGEL Reactor). Faure, J.; Reynen, J. (European Atomic Energy Community, Ispra (Italy). Joint Nuclear Research Center). Feb. 1968. 44p. (In French). Dep.

The feasibility of cold fins, welded to a Zircaloy coolant channel, to serve as a hydrogen sink has been studied from the thermal point of view. Temperature distributions and additional thermal losses have been determined by means of a model. This model has been verified by experiment. (auth)

22814 (GEAP-5498) SOUTHWEST EXPERIMENTAL FAST OXIDE REACTOR DEVELOPMENT PROGRAM. Quarterly Report No. 12, February–April 1967. Pflasterer, G. R. (General Electric Co., Sunnyvale, Calif. Advanced Products Operation). May 1967. Contract AT(04-3)-540. 64p. Dep. CFSTI.

SOUTHWEST EXPERIMENTAL FAST OXIDE REACTOR — operations during February to April 1967; fuel assembly for, stability of heated mockup; power reactivity transfer functions for 0 to 20 MW in, paint reactor model calculation of
REACTIVITY — transfer functions in SEFOR for 0 to 20 MW operation, measurement of
REACTOR FUEL ELEMENTS — assembly of SEFOR, description of heated mockup; mechanical properties of SEFOR treated mockup assembly of testing for
REMOTE-HANDLING EQUIPMENT — description of heated mockup SEFOR fuel assembly
REACTOR CONTROL ELEMENTS — description of SEFOR
REACTOR EXPERIMENTAL FACILITIES — description of SEFOR foil container
FLUID FLOW — measurement of SEFOR reactor core coolant (D.C.C.)

22815 GEAP-5595) SOUTHWEST EXPERIMENTAL FAST OXIDE REACTOR DEVELOPMENT PROGRAM. Quarterly Report No. 15, November 1967–January 1968. Pflasterer, G. R. (comp.) (General Electric Co., Sunnyvale, Calif. Advanced Products Operation). Feb. 1968. Contract AT(04-3)-540. 19p. Dep. CFSTI.

A summary of the tasks scheduled for activity during Phase 1 of the Research and Development Program for the Southwest Experimental Fast Oxide Reactor is presented. (D.C.C.)

22816 (HW-75557(Rev.)(Del.)) DECONTAMINATION OF THE PLUTONIUM RECYCLE TEST REACTOR. Ayres, J. A.; Demmitt, T. F.; Hayden, K. D.; Perrigo, L. D.; Weed, R. D. (General Electric Co., Richland, Wash. Hanford Atomic Products Operation). May 1963. Contract AT(45-1)-1350. 96p. Dep. CFSTI.

The decontamination process for the Plutonium Recycle Test Reactor is described. A description of PRTR operations during 1961 and 1962 is presented. The description includes the fuel element rupture and events that followed. Mechanical and chemical decontamination methods are described. Corrosion effects on reactor materials are analyzed, and activity readings before, during and after the decontamination process are presented. (D.C.C.)

22817 (IDO-17231) SAFETY ANALYSIS REPORT FOR FRAN PROMPT BURST MACHINE. Gossmann, S. R.; Gottschalk, V. B. (Phillips Petroleum Co., Idaho Falls, Idaho. Atomic Energy Div.). Sept. 1967. Contract AT(10-1)-205. 100p. Dep. CFSTI.

The FRAN Prompt Burst Machine is described with particular emphasis placed on the neutronic characteristics, the control and instrumentation systems, and plant safety considerations. The plan of operation is discussed and significant operating procedures are included. The site properties are described and analyzed with respect to safety. Hazards which could result from both normal and abnormal operation are analyzed. It is concluded that operation of the FRAN machine at the NRTS can be conducted with no undue hazards to operating personnel, the general public, or facilities. (auth)

22818 (IDO-17231(Add.)) SAFETY ANALYSIS REPORT FOR FRAN PROMPT BURST MACHINE. Gossmann, S. R.; Gottschalk, V. B. (Phillips Petroleum Co., Idaho Falls, Idaho. Atomic Energy Div.). Feb. 1968. Contract AT(10-1)-205. 18p. Dep. CFSTI.

Operating procedures and investigation of errors needed to produce an oversized burst in FRAN Prompt Burst Machine are presented. (auth)

22819 (IDO-17241) ENGINEERING AND TEST BRANCH QUARTERLY TECHNICAL REPORT, JULY 1967–SEPTEMBER 1967. Dietz, K. A. (ed.) (Phillips Petroleum Co., Idaho Falls, Idaho. Atomic Energy Div.). Feb. 1968. Contract AT(10-1)-205. 44p. Dep. CFSTI.

Parametric studies of the nuclear design of the LOFT core were

conducted to determine the effect changes in control rod and fuel pin configurations have on the core nuclear characteristics. Nuclear characteristics of open-lattice control rods were investigated to ascertain the effects of varying poison pin spacings. Reactor cores having the thermal-hydraulic characteristics associated with PWR designs permitting free radial flow were studied. Preliminary results of these studies indicate that a modified LOFT-ECCS core can be adequately controlled with open-lattice cruciform control rods. Fuel pin spacings and diameters, fuel enrichments, and enrichment zones remain to be specified. Three-dimensional power distributions and critical rod positions were calculated for the LOFT core. The power distributions were for 100, 400, and 800 hours of operation at 50 MW. Critical control rod positions obtained using the TNT02 computer program agreed with those obtained through the RZ-TURBO program. Iodine-131 and -135 releases to the fuel rod plenum were calculated using Oak Ridge National Laboratory experimental data. Reactor operation times of 30 and 1000 hours were assumed. The calculations were based on the average temperature distribution for the hottest and average pins in LOFT. The release values were calculated for 8.05 days and 6.7 hours for I-131 and I-135, respectively. A containment spray system is to be tested during the LOFT emergency core cooling sequence. This system is designed to remove airborne fission products and to reduce the temperature and pressure of the containment building. The efficiency of the spray system for removal of iodine was investigated. Impaction and diffusion models were studied for use in describing spray drop efficiency. (auth)

22820 (KFK-688) BETRIEBSBERICHT UEBER DEN FORSCHUNGSREAKTOR FR2 FUER DAS JAHR 1966. (Operating Report on the Research Reactor FR2 for the Year 1966). Steiger, W. (Kernforschungszentrum, Karlsruhe (West Germany)). Oct. 1967. 36p. (In German). Dep.

An operations history of the FR-2 is given. Reactor loading diagrams and experiment positions are shown. Reactor scrams are tabulated with remarks noted; power decreases are tabulated, also. (M.L.S.)

22821 (LA-DC-9216) CRITICALITY AND CENTRAL REACTIVITY CALCULATIONS USING ENDF/B DATA. LaBauve, R. J.; Battat, M. E. (Los Alamos Scientific Lab., N. Mex.). [1968]. Contract W-7405-eng-36. 7p. (CONF-680307-23). Dep. CFSTI.

From 2nd Conference on Neutron Cross Sections and Technology, Washington, D. C.

A series of criticality calculations has been performed for selected experimental assemblies to test the Category I, ENDF/B neutron data. These assemblies include JEZEBEL (plutonium core), TOPSY (enriched uranium core with natural uranium reflector), and ZPR-3 Assembly 48 (plutonium fuel, soft spectrum). Central reactivity worths were also computed for several materials of interest in fast reactor design. In the course of obtaining multigroup constants for input to the Los Alamos Scientific Laboratory codes used in these calculations, several ENDF/B retrieval and processing codes were employed. These include DAMMET, a code for rearranging and altering the mode of the standard BCD ENDF/B library tape; ETOE, a code for preparing an MC^2 library tape; and MC^2, a code for generating multigroup constants from microscopic neutron data. Calculational results have been compared with experiment as well as results obtained using other nuclear data libraries. (auth)

22822 (MIT-1967-1) RESEARCH AND EDUCATIONAL ACTIVITIES AT THE MIT RESEARCH REACTOR TO AND INCLUDING FISCAL YEAR 1967. (Massachusetts Inst. of Tech., Cambridge. Dept. of Nuclear Engineering). Dec. 1967. Contract AT(30-1)-1967. 134p. (MITNE-91). Dep. CFSTI.

A report of research and educational activities which utilized the Massachusetts Institute of Technology, five-megawatt, heavy water, research reactor during fiscal year 1967 has been prepared for administrative use at MIT and for presentation to the U. S. Atomic Energy Commission. The latter action is required by Contract AT(30-1)-1967 under which the AEC provides the fully enriched uranium-235 fuel and the heavy-water moderator-coolant for the reactor. Research projects at MIT which make significant use of the MITR are described, and principal participating personnel are named. Listings are provided of theses, reports, journal articles, and conference papers resulting from these projects during fiscal year 1967. In addition, since no comprehensive bibliography of these publications has previously been issued, the report lists essentially all documents of these types which are concerned with the design, operation, or research use of the MITR since its construction was first contemplated at the Institute. In addition to the educational value derived from the many research activities by the students who participate in them, training in several areas of nuclear technology is imparted through formal courses designed to make use of the reactor or its research projects. The courses are briefly described, and attendance figures are given. Detailed information concerning the research activities of the numerous other universities, hospitals, and commercial companies which have used the MITR for irradiations is not available, but these organizations and also the materials irradiated are listed. The reactor, its purpose, its organization, and a summary of operations are briefly described in order to provide a more complete understanding of the MITR program. 103 references. (auth)

22823 (ORNL-4219, pp 119-20) SUPPORT FOR IN-PILE EXPERIMENTS. (Oak Ridge National Lab., Tenn.).

Instrument engineering support because of changes in research parameters and equipment in various reactors required 2 man-years of work. A technique of prefabricating instrument and control systems for planned in-pile experiments was developed and tested. Experiments in the ORR were instrumented. (H.D.R.)

22824 (ORNL-4219, pp 121-4) INSTRUMENTATION FOR REACTOR DIVISION TEST LOOPS. (Oak Ridge National Lab., Tenn.).

Instrumentation activities are reviewed for: liquid-metal corrosion loops, a high pressure loop, a high-burnup coated-particle irradiation experiment, an evaporator desalination pilot plant, a fission product deposition loop, a hyperfiltration desalination loop, prestressed concrete pressure vessel model tests, an oil seal test experiment, radiation monitors in the plutonium fuel test capsule assembly area, and research projects of the Reactor Division Engineering Science Department. (H.D.R.)

22825 (PINSTECH/RO-4) CONTROL ROD CALIBRATION AND REACTIVITY MEASUREMENTS OF EXPERIMENTAL FACILITIES AT THE PAKISTAN RESEARCH REACTOR. Shafique, M.; Akhtar, K. M.; Hashmi, M. F.; Kria, Said (Pakistan Inst. of Nuclear Science and Technology, Islamabad. Reactor Operation and Maintenance Div.). June 1967. 42p. Dep.

The control rods of the Pakistan Research Reactor have been calibrated by the Comparison and the Inhour methods. The water to air filled reactivity change for all the beam tubes and the reactivity worth of the graphite thermal column have also been measured. The total worth of all the control rods, obtained by the Inhour Method has been found to be 15.942% $\Delta K/K$ in the open end and 16.571% $\Delta K/K$ in the stall end. The total loss in reactivity for water to air filled beam tubes was found to be 0.953% $\Delta K/K$ and the worth of the thermal column is 1.263% $\Delta K/K$. (auth)

22826 (RT/FI-(67)26) DIGITAL CORRELATION ANALYSIS OF OSCILLATION MEASUREMENTS. Ferrari, T.; Martinelli, R.; Musco, A.; Santandrea, E. (Comitato Nazionale per l'Energia Nucleare, Rome (Italy)). 1967. 24p. Dep.

The input-output cross-correlation technique has been applied to analyze the response of the RANA reactor to power modulation due to oscillation of absorbing samples. The method and electronic equipment used are described; some preliminary results obtained in effective cross section and spectral index measurements are reported. (auth)

22827 (RT/FI-(67)29) PROGETTO PRELIMINARE E VALUTAZIONE ECONOMICA DI UN REATTORE TIPO CIRENE ALIMENTATO AD OSSIDO DI TORIO. (Preliminary Design and Economic Evaluation of a Cirene Type Reactor Fueled With Thorium Oxide). Cardosi, G.; Mazzanti, A.; Venditti, P. (Comitato Nazionale per l'Energia Nucleare, Rome (Italy)). 1967. 153p. (In Italian). Dep.

A thorium oxide fueled Cirene type reactor is considered. An economical optimization of the energy cost as a function of the most important design parameters is performed. An analysis of the influence, on total energy cost, of the variations of some characteristic data is carried out; the main features of a reference 500 MWe power station are defined. (auth)

22828 (AERE-Trans-1085) NEUTRON THERMALIZATION IN A GRAPHITE-WATER SYSTEM AT LARGE TEMPERATURE GRADIENTS. Maiorov, L. V.; Mostovoi, V. I.; Safin, Yu. A.; Trukhanov, G. Ya. (Gosudarstvennyi Komitet po Ispol'zovaniyu Atomnoi Energii SSSR, Moscow. Institut Atomnoi Energii). Translated by A. Crozy for Atomic Energy Research Establishment, Harwell, Eng., from report IAE-843. 19p. Dep. CFSTI. UK 2s. 6d. JCL $1.60 fs, $0.80 mf.

Also published in Pulsed Neutron Res., Proc. Symp. Karlsruhe, 1965, 1: 657-68(1965). (STI/PUB-104(Vol.1, 657-68); SM-62/109).

Measurements were made of the space-energy distribution of thermal neutrons in a graphite-water system at graphite temperatures of 443 to 823°K and a water temperature of 303°K. The system investigated consisted of a graphite prism, measuring

100 cm × 100 cm × 59.5 cm, and an aluminum tank of water measuring 175 cm × 175 cm × 50 cm, separated by a thermal screen. The WWR-2 reactor was used as the external neutron source. Neutron beams were extracted from different points in the graphite and the water in the direction of the neutron flux from the reactor incident on the graphite prism. The neutron spectra in the extracted beams were measured by the time-of-flight method using a mechanical chopper with a resolution of 20 μs/m. The spectra were compared with the spectra calculated in accordance with a T-2 programme (P-1 approximation, 40 energy groups), use being made of the differential cross-sections for an ideal gas and the differential cross-sections obtained taking into account the chemical binding. Using the method described the neutron rethermalization cross-sections in the graphite and the water were calculated as a function of graphite temperature on the basis of the measured spectra. The experimental results were compared with the data obtained by other authors. (auth)

22829 (EURFNR-424) INVESTIGATIONS ON LOADS 3 AND 4 OF STARK, THE FAST THERMAL ARGONAUT REACTOR. Barleon, L.; Brueckner, Chr.; Burkart, K.; Fieg, G.; Kuhn, D.; Kussmaul, G.; Meister, H.; Seufert, H.; Stegemann, D.; Werle, H. (Kernforschungszentrum, Karlsruhe (West Germany). Institut fuer Neutronenphysik und Reaktortechnik). Translated from report KFK-668. 106p. Dep. CFSTI.

Work Performed under United States–Euratom Fast Reactor Exchange Program.

Load 4 was inserted in STARK to obtain the maximum possible fast-fission zone reactivity and power fraction, with a hard neutron spectrum, while remaining within the safeguard limits laid down by the safety assessment. With this load, the reactor was to exhibit the "standard load" characteristics calculated by 4-group computation in the safety assessment. But in the light of new 26-group calculations (ABN set) and comparisons with experimental data for Loads 1 and 2, Load 4 had to have greater enrichment in the fast fission zone than foreseen for the "standard load," the qualitative composition of the fast core remaining otherwise the same. It was necessary to check the predictions of the 26-group calculation as comprehensively as possible, to ensure that when Load 4 was in the reactor the margin left by the safeguard guarantees was used to the full without the limits being exceeded. For this purpose, prior to the insertion of Load 4, Load 3 was built in as a "standard load" and a measurement program was carried out to verify the 26-group calculations. (auth)

22830 TESTS OF EXPERIMENTAL ASSEMBLY WITH A ROD TYPE FUEL ELEMENT WITH SINTERED UO_2 CORE IN ZIRCONIUM CLADDING WITH MAXIMUM BURN-OUT OF 68,000 MW DAY/TON URANIUM. Amaev, A. D.; Amvartsumyan, R. S.; Goncharov, V. V.; Glukhov, A. M.; Dubrovin, K. P.; Ivanov, E. I.; Lebedev, L. M.; Pravdyuk, N. F.; Ryazantsev, E. P. (Inst. of Atomic Energy, Moscow). pp 143-57 of Conference on the Use of Zirconium Alloys in Nuclear Reactors, October 20–21, 1966, Marianske Lazne, Czechoslovakia. General Proceedings. I. Plzen, Czechoslovakia, Skoda Works, [1966]. (In Russian).

See CONF-661059-(Vol.1)).

The results of in-pile and post irradiation tests of an experimental assembly of the icebreaker-type rod fuel element with the sintered UO_2 and Zr–1% Nb alloy cladding are presented. The results of metallographic and mechanical investigations are also presented. The assembly operated for 10000 hours in hot pressurized water without failure. (auth)

22831 INTERPRETATION OF BUCKLING MEASUREMENTS IN SMALL EXPONENTIAL STACKS. Chudley, C. T. (Bath Univ. of Technology, Bristol, Eng.); Terry, M. J. pp 44-7 of The Physics Problems in Thermal Reactor Design. London, British Nuclear Energy Society, 1967.

From International Conference on Physics Problems of Thermal Reactor Design, London. See CONF-670607.

The problem of making corrections to experimentally measured bucklings when the experimental stack is too small for a satisfactory measurement is discussed. Results of calculations on one particular core at A.E.E. Winfrith are presented, and suggest that the use of a small number of groups and of diffusion theory may be inadequate for such a calculation. (auth)

22832 URANIUM AND URANIUM–PLUTONIUM FUELLED LATTICES WITH GRAPHITE AND HEAVY WATER MODERATOR. A COMPARISON OF EXPERIMENT WITH PREDICTION. Cogne, F.; Meyer-Heine, A. (CEA, Saclay, France). pp 48-58 of The Physics Problems in Thermal Reactor Design. London, British Nuclear Energy Society, 1967.

From International Conference on Physics Problems of Thermal Reactor Design, London. See CONF-670607.

Experiments on graphite-uranium lattices are compared to the COREGRAF code predictions. The agreement is satisfactory over a wide range of lattices, but a discrepancy remains as far as the temperature coefficient is concerned. Results on uranium-plutonium fuel experiments carried out in the heavy-water and graphite facilities Aquilon and César are also compared with calculations. (auth)

22833 PULSED SOURCE MEASUREMENTS ON SUB-CRITICAL ASSEMBLIES OF NATURAL URANIUM AND LIGHT WATER. Rogers, J. D. (Univ. of Birmingham, Eng.). pp 59-62 of The Physics Problems in Thermal Reactor Design. London, British Nuclear Energy Society, 1967.

From International Conference on Physics Problems of Thermal Reactor Design, London. See CONF-670607.

Pulsed source measurements of prompt neutron decay constants at different bucklings in a natural uranium/H_2O assembly are compared with four-group diffusion theory and multigroup calculations based on the Carlson S_N method. Experimental values of k_{eff} derived by the Gozani and Garelis-Russell technique are compared with the calculated eigenvalues. (auth)

22834 THERMAL NEUTRON SPECTRA IN U–H_2O LATTICES. Mansfield, W. K.; Roshd, M. H. M. (Queen Mary Coll., London). pp 76-8 of The Physics Problems in Thermal Reactor Design. London, British Nuclear Energy Society, 1967.

From International Conference on Physics Problems of Thermal Reactor Design, London. See CONF-670607.

Thermal neutron spectra were measured at the centre of two lattices with volume ratios V_{H_2O}/V_U of 1.59 and 1.11. The fuel elements were 1.2 in. dia and contained 0.925% ^{235}U. Measurements were taken perpendicular to the fuel element axis at the can surface and in the water 0.25 in. from the can. The results agreed reasonably with those predicted by a DSN calculation (S_8 approximation) using the effective width model for scattering in water. (auth)

22835 STUDIES OF BERYLLIUM OXIDE-MODERATED REACTORS USING MINIMAL QUANTITIES OF MATERIAL. Connolly, J. W.; Gemmell, W.; Marks, A. P.; Tattersall, R. B. (Australian Atomic Energy Commission Research Establishment, Lucas Heights, New South Wales). pp 83-90 of The Physics Problems in Thermal Reactor Design. London, British Nuclear Energy Society, 1967.

From International Conference on Physics Problems of Thermal Reactor Design, London. See CONF-670607.

Small BeO-moderated subcritical assemblies fueled with ^{235}U were studied in the internal reflector of an Argonaut-type reactor. Thoria was added in some cases. Measurements were compared with multigroup calculations, and the agreement was satisfactory. (auth)

22836 CHALK RIVER STUDIES OF D_2O MODERATED NATURAL URANIUM AND ^{235}U–THORIUM LATTICES. Okazaki, A.; Townes, B. M.; Durrani, S. A. (Atomic Energy of Canada Ltd., Ontario). pp 95-102 of The Physics Problems in Thermal Reactor Design. London, British Nuclear Energy Society, 1967.

From International Conference on Physics Problems of Thermal Reactor Design, London. See CONF-670607.

Progress is described on an investigation into the adequacy of the four-factor two-group description of the neutron cycle, by comparison with experimental measurements. Maximum use is made of experimental information, but some theory and basic nuclear data are involved. The calculated k_{eff} values show systematic trends with pitch and type of fuel cluster, and with coolant. Explanations for these trends are being sought. In addition, lattice parameter measurements on D_2O-moderated lattices of 19-element rods of ThO_2 containing 1.5 wt. % $^{235}UO_2$ are reported. The measurements were made for four coolants over a range of lattice pitches. (auth)

22837 STUDIES OF SINGLE-ROD LATTICES OF UO_2 (NATURAL AND ENRICHED), PuO_2 OR ThO_2 IN HEAVY WATER. Wikdahl, C.-E.; Sokolowski, E.; Persson, R.; Jonsson, A.; Andersson, A. J. W. (Aktiebolaget Atomenergi, Stockholm). pp 103-10 of The Physics Problems in Thermal Reactor Design. London, British Nuclear Energy Society, 1967.

From International Conference on Physics Problems of Thermal Reactor Design, London. See CONF-670607.

Extensive studies were carried out on single-rod lattices in heavy water. Fuel rod composition, lattice pitch and (in some cases) temperature were the parameters varied. Bucklings, spectral indices and conversion ratios were measured. The experimental results were compared with calculated values obtained with the four-group program CAROL, and the more advanced cell program FLEF, which is based on multigroup integral transport theory. (auth)

22838 MEASUREMENT OF MATERIAL BUCKLING AND DIFFUSION COEFFICIENT IN HEAVY WATER MODERATED

LATTICES CONTAINING NATURAL UO_2 FUEL CLUSTERS. Heer, W. (Eidgenoessisches Institut fuer Reaktorforschung, Wuerenlingen, Switzerland); Lutz, H. R.; Richmond, R.; Persson, R. pp 111-16 of The Physics Problems in Thermal Reactor Design. London, British Nuclear Energy Society, 1967.

From International Conference on Physics Problems of Thermal Reactor Design, London. See CONF-670607.

A description is given of a series of experiments carried out in support of Swiss reactor assessment studies on heavy water moderated lattices containing natural UO_2 cluster fuel elements. The experiments, which involved measurements of material buckling and diffusion coefficients, were designed to give a comparison of the results of measurements on single-zone lattices in the Swiss subcritical assembly MINOR with those given by substitution measurements in the Swedish reactor RO. A comparison of the two sets of experimental data confirmed that accurate results can be obtained by the substitution method using very small numbers of fuel clusters, but showed that, in some cases, the method may be significantly in error, and emphasized the need to investigate the conditions in which these errors may occur. The results of the buckling measurements were compared with the predictions of the UKAEA assessment code METHUSELAH and the Swedish code REBUS. Both codes were shown to give satisfactory results over the range of lattices examined. The measured coefficients were well predicted by the theory of Benoist. (auth)

22839 HEAVY WATER LATTICE ANALYSES AT ISPRA. Amyot, L.; Birkhoff, G.; Casini, G.; (and others). (CCR-EURATOM, Ispra, Italy). pp 117-24 of The Physics Problems in Thermal Reactor Design. London, British Nuclear Energy Society, 1967.

From International Conference on Physics Problems of Thermal Reactor Design, London. See CONF-670607.

A review is presented of the experimental program and of the methods of analysis set up for the investigation of heavy water lattices. A description of the different experimental techniques and methods of interpretation presently in use is given, and the results are compared to theoretical values. (auth)

22840 CORE REPRESENTATION IN SGHW REACTORS. Allen, F. R.; Newmarch, D. A. (United Kingdom Atomic Energy Authority, London). pp 139-46 of The Physics Problems in Thermal Reactor Design. London, British Nuclear Energy Society, 1967.

From International Conference on Physics Problems of Thermal Reactor Design, London. See CONF-670607.

Core representation models are described which were developed for the design and performance assessment of SGHW reactors. Comparisons are presented between theoretical predictions and experimental measurements which establish the validity of the design models. Application of heterogeneous reactor theory to SGHW core calculations is described. (auth)

22841 THE USE OF HETEROGENEOUS METHODS AT ISPRA. Casini, G.; Hage, W.; Kind, A. (CCR-EURATOM, Ispra, Italy). pp 147-51 of The Physics Problems in Thermal Reactor Design. London, British Nuclear Energy Society, 1967.

From International Conference on Physics Problems of Thermal Reactor Design, London. See CONF-670607.

The heterogeneous methods developed and used at Ispra for thermal reactor calculations are presented. Results using these methods are compared with uniform substitution and mixed lattice experiments carried out in the critical facility ECO. (auth)

22842 PHYSICS STUDIES IN WAGR AND HERO. Clark, A. C.; Higham, E. J.; Leng, J. H.; McGhee, J.; Snape, G. P. (United Kingdom Atomic Energy Authority, Windscale, Eng.). pp 183-92 of The Physics Problems in Thermal Reactor Design. London, British Nuclear Energy Society, 1967.

From International Conference on Physics Problems of Thermal Reactor Design, London. See CONF-670607.

Measurements of power distributions, core reactivities and temperature coefficients made in HERO and WAGR are compared with theoretical predictions. Calculations based on the computer codes ARGOSY and RAVEN generally give very close agreement with the measurements, except in the case of the power distributions measured in WAGR, where the experimental error is higher and the reactor composition less well defined. (auth)

22843 SN RATIO IN THE ROSSI-α EXPERIMENT. Yamamuro, Nobuhiro; Inaba, Gohzoh (Tokyo Inst. of Tech.). J. Nucl. Sci. Technol. (Tokyo), 5: 140-1(Mar. 1968).

A Rossi-α experiment was performed on a light water moderated and reflected 20% enriched uranium system to evaluate the accuracy of a method for obtaining the SN ratio, which is necessary for determining the counting efficiency of the neutron detector. The correlated term for obtaining the true SN ratio was calculated and plotted against the measured prompt neutron decay constant. The usefulness and accuracy of this method are discussed. (H.D.R.)

22844 INTERPRETATION OF CRITICAL EXPERIMENTS WITH URANIUM-PLUTONIUM FUEL ELEMENTS. Naudet, R. (Centre d'Etudes Nucleaires, Saclay, France). pp 109-25 of Fuel Burn-up Predictions in Thermal Reactors. Vienna, International Atomic Energy Agency, 1968. (In French).

From IAEA Meeting on Fuel Burnup Predictions in Thermal Reactors, Vienna, Austria. See STI/PUB-172; CONF-670418.

A set of critical experiments performed successively in the heavy-water pile AQUILON II and the graphite pile CESAR was designed to compare the neutron properties of the two lattices, which are geometrically identical but in which the fuel composition is slightly different. The same fuel elements were used in the two piles, i.e., uranium metal rods of uniform diameter. The following compositions were compared: Control set: natural uranium; Set used as an intercomparison standard: uranium very slightly depleted or enriched in ^{235}U (0.69%-0.83%-0.86%); Three sets to be studied containing plutonium: 1P: natural uranium + 0.04% plutonium; 2P: highly depleted uranium + 0.30% plutonium; 3P: similar to 1P but with plutonium containing a higher proportion of the isotope ^{240}Pu. In AQUILON the experiments were performed over a whole series of lattice spacings so as to vary the spectrum over a wide range, but all the measurements, with one exception, were made at environmental temperature. In CESAR, the experiments involved only one or two spacings, but a wide range of temperature. Up to the present time measurements have been made at 20, 100 and 200°C, and they will be continued at 300 and 400°C. The purpose of these experiments is to obtain data on which to evaluate the equivalence between ^{235}U and plutonium in conditions similar to those encountered in natural uranium reactors during irradiation, and to test the calculation methods. The experiments performed in AQUILON are described in greater detail, but the results already obtained in CESAR are also indicated by way of comparison. (auth)

22845 EXCITATION OF HIGHER SPACE MODES IN REACTOR TRANSFER FUNCTION MEASUREMENT. PART I. Saji, Genn (Univ. of Illinois, Urbana). Nucl. Sci. Eng., 32: 93-100(Apr. 1968).

An explicit time-dependent two-group flux, expressed by a series of space modes, is established when a forced oscillation is applied to a reactor. The self-consistent time-dependency method developed here minimizes necessary mathematical transformations and enables one to clearly visualize the physical reasons why the higher space modes are only excited at high frequencies. The conditions necessary for a particular higher space mode to be appreciably excited and detected are discussed in detail. The results show that the major factor is due to the increase of the input frequency as compared with the decay constants of several higher space modes at high frequencies. This method was applied to the NORA reactor for which the space-dependent transfer functions have been measured. Results of the calculations closely agree with the published experimental results as well as with theoretical gain and phase shift curves obtained by the conventional modal expansion-Laplace transform method. The relative amplitude of each higher space mode with respect to the fundamental mode shows the rate of convergence of the modal expansion method. (auth)

22846 REACTOR NOISE MEASUREMENTS USING GAMMA RAYS. Lehto, Wayne K.; Carpenter, John M. (Univ. of Michigan, Ann Arbor). Nucl. Sci. Eng., 32: 142-6(Apr. 1968).

Results of a set of reactor noise measurements with a gaseous Čerenkov detector are presented. The measurements were made by observing the prompt fission gamma rays instead of neutrons. The two-detector cross power spectral density measurements are described and evaluated. (H.D.R.)

22847 THE DELAYS IN THE CONSTRUCTION AND COMMISSIONING OF THE MAINZ TRIGA. Balke, S. Atomwirt., Atomtech., 12: 406-8(Aug.-Sept. 1967). (In German).

A chronology of the delays encountered in the construction and commissioning of the Mainz TRIGA facility is given. Causes for delays are cited as financing, licensing, and reactor tank materials. (M.L.S.)

22848 AN AUTOMATIC STARTUP OF HTR WITH A DIGITAL SYSTEM. Taguchi, Toyohira; Takumi, Kenji (Hitachi Central Research Lab., Japan). J. Nucl. Sci. Technol. (Tokyo), 4: 321-7 (July 1967).

Automatic startup and power control of HTR was performed with the use of a single purpose digital computer. One of the aims of this experiment was to develop control system for HTR and to clarify certain problems related to digital reactor startup control. The reactor power was controlled automatically from

source range to preset output in 9 min. The digital computer control system successfully performed the prescribed functions. The reactor was best controlled when the loop gain was adjusted for proper period. This optimized value of gain was slightly lower than ideal for power control, and hence a slight overshoot in power was seen, though to a degree small enough to be permissible for the various experimental purposes foreseen for the HTR. (auth)

22849 IMPROVEMENTS IN THE VVR-S REACTOR, BUDAPEST. Varkonyi, Lajos (Central Physical Research Inst., Budapest). Atomtech. Tajek., 10: 633-44(1967). (In Hungarian).

The light-water moderated and reflected VVR-S research reactor, started up on March 25, 1959, has operated at a power rating of 2 MW and a maximum thermal neutron flux of 2×10^{13} n/cm^2, using 10% enriched fuel rods; because of the great variety of uses to which it was put the reactor was rebuilt and the experimental facilities were improved. The useful neutron yield was doubled; it was tried to avoid replacement of the already installed equipment. The new cooling water circuit is able to remove 5 MW of heat at a circulation rate of 700 m^3/hour. The beam-hole use for biological irradiations is located at a center plane of the core; the four filters with which it is provided makes it possible to operate in different spectral ranges. The facility accomodates animals up to the size of a rabbit. Special, heavy-concrete shields were used to reduce the background level. The control system of the reactor was also modernized. The rebuilt reactor now carries the designation of VVR/SM. (TTT)

22850 NEW METHOD OF TEMPERATURE CONTROL IN CAPSULE IRRADIATION VACUUM CONTROL METHOD. Hayashi, Takao; Ouchi, Shinpei; Ishii, Tadahiko (Japan Atomic Energy Resarch Inst., Ibaraki). J. Nucl. Sci. Technol. (Tokyo), 4: 381-3(July 1967).

Temperature control of the specimen is accomplished by using only one gas in the gas gap and controlling the pressure, thus controlling the thermal conductivity. This method provides a very wide control range. (W.H.K.)

22851 FEATURES OF AND OPERATING EXPERIENCE WITH THE HFIR PROTECTION SYSTEM. Bates, A. E. G.; Epler, E. P.; Oakes, L. C. (Oak Ridge National Lab., Tenn.). Nucl. Appl., 4: 289-96(May, 1968).

The ORNL second generation of protection systems, as applied to the High Flux Isotope Reactor, (HFIR), has three independent channels, each with seven inputs; some of the inputs are calculated automatically and continuously. General coincidence logic was selected to permit on-line testing of complete channels and on-line maintenance. Although some designers consider local coincidence systems less likely to cause spurious scrams due to equipment failures, operating experience with the HFIR system has been entirely satisfactory. The reactor has been operating at full power for 13 months to Oct. 1967; there has been one safe scram but no unsafe equipment failures. Sufficient confidence has been gained in the equipment to increase the test interval from 8 to 24 hours. On-line maintenance has advantages over off-line maintenance in addition to conservation of downtime, and tends to enhance safety. 7 references. (auth)

22852 FAST NUCLEAR REACTOR AS A PULSED NEUTRON SOURCE. Kistner, G.; Meister, H.; Raievski, V. (to EURATOM). Canadian Patent 777,860. Feb. 6, 1968. Priority date Aug. 15, 1963, Germany.

The reactor core, located in a reflector, is provided with a neutron outlet window. A pre-pulse screen and an excess-pulse screen having synchronized movements and movable in overlapping relationship, is placed in front of the window. These screens are composed of reactivity increasing materials. There is a means to operate the pre-pulse screen to bring the reactivity near the critical point and simultaneously to pulse the reactivity above the prompt critical point by movement of the excess pulse screen. The improvement consists of several slots arranged in line and in the direction of movement of the pre-pulse screen together with several zones of reactivity increasing materials similarly provided at the overlap locations in the excess-pulse screen. The distances from slot to slot and from zone to zone vary in such a way that upon full overlap of the screens, all the slots are covered by the zones while in all other positions only one slot is so covered. (F.S.A.)

22853 FAST NUCLEAR REACTOR AS A PULSED NEUTRON SOURCE. Kistner, G.; Raievski, V.; Misenta, R. (to EURATOM). Canadian Patent 777,861. Feb. 6, 1968. Priority date Aug. 15, 1963, Germany.

Two neutron outlet windows are used in this device rather than a single window. The rotating pre-pulse and excess-pulse screens have synchronized movements in front of the windows. The one for the excess-pulse screen consists of several slots which are narrow compared to the window for the pre-pulse screen. The aligned slots forming the excess pulse window are not equidistant. The excess-pulse screen consists of zones of reactivity increasing material with spacing corresponding to the spacing of the aligned slots of the excess-pulse window. (F.S.A.)

Reactor Theory, Components, Fuels and Accessories

Refer also to abstracts 21167, 21294, 21388, 21390, 21645, 21647, 21649–21651, 21684, 21700, 21714, 21758, 21759, 21778, 22519, 22525–22529, and 22711.

22854 (ANL-RE-391) FUEL-ELEMENT LIFETIME. Bump, T. R. (Argonne National Lab., Ill.). [1967]. 12p. Dep. CFSTI.

Problems in prediction of fuel element lifetime are discussed. Use of the SWELL computer code for lifetime calculations is described; results are shown graphically. The BULGE, CYCRO, and NUKER codes are described briefly. 9 references. (M.L.S.)

22855 (GA-8511) PCRV CAVITY LINER AND PENETRATION LINERS AND CLOSURES. Peinado, C. O. (Gulf General Atomic, Inc., San Diego, Calif.). Feb. 23, 1968. Contract AT(04-3)-633. 32p. Dep. CFSTI.

A description of cavity and penetration liners and closures for prestressed concrete reactor vessels is given. Design criteria for the liners and closures are presented; materials specifications are outlined. Construction procedures and necessary quality control are discussed. (M.L.S.)

22856 (ITEF-539) DVE LEKTSII O YADERNYKH REAKTORAKH I PRINTSIPE MAKSIMUMA L. S. PONTRYAGINA. (Two Lectures on Nuclear Reactors and L. S. Pontryagin's Maximum Principle). Rudik, A. P. (Gosudarstvennyi Komitet po Ispol'zovaniyu Atomnoi Energii SSSR, Moscow. Institut Teoreticheskoi i Eksperimental'noi Fiziki). 1967. 60p. (In Russian). Dep.

A method was developed on the basis of L. S. Pontryagin's maximum principle for optimizing the operating conditions, in order to solve reactor problems for cases, in which limiting conditions derived from constructional or heat-transfer considerations are applied. In order to carry out the optimization steps, an initial system of equations is formulated for $x^{(i)}$, determining the Hamiltonian and deriving an equation system for Ψ. All of the possible types of control are established for the Hamiltonian; a qualitative solution may be obtained only if the number of variables $x^{(i)}$ is small. The optimum solution may be determined by computer calculations. The method presents the advantage that it allows to determine conveniently the permissible types of control. If a neutron-pulse method is used, the correct position of the transducers must be determined by means of Pontryagin's maximum principle. (TTT)

22857 (MIT-2344-11) USE OF A MOMENTS METHOD FOR THE ANALYSIS OF FLUX DISTRIBUTIONS IN SUBCRITICAL ASSEMBLIES. Cheng, H. S.; Kaplan, I.; Thompson, T. J.; Driscoll, M. J. (Massachusetts Inst. of Tech., Cambridge. Dept. of Nuclear Engineering). Feb. 1968. Contract AT(30-1)-2344. 353p. (MITNE-84). Dep. CFSTI.

A moments method has been developed for the analysis of flux distributions in subcritical neutron-multiplying assemblies. The method determines values of the asymptotic axial and radial buckling, and of the extrapolated height and radius from foil activation data in terms of flux moments defined in the usual sense. Analytic expressions are derived for the axial and radial buckling and extrapolated dimensions in terms of the flux moments. These expressions have clear physical meaning and are suitable for the interpretation of conventional buckling measurements. The method treats the moment index as a variable parameter and allows freedom in the choice of the locations of the first and last data points used in the analysis. These degrees of freedom make it possible to reduce the effects of source neutrons, flux transients, and higher harmonics. As a result, the moments method can be applied successfully to very small lattices ("miniature lattices") as well as to large exponential assemblies. The moments method has been tested, in comparison with the conventional least-squares curve-fitting method, by applying the two methods to the analysis of measurements made in several uranium-heavy water, and uranium oxide-heavy water lattices investigated at the M.I.T. Lattice Project. In the case of large exponential assemblies, the moments method yielded more consistent results than the curve-fitting method. In the case of miniature lattices, the moments method

made it possible for the first time to determine values of axial and radial buckling and extrapolated dimensions. (auth)

22858 (ORNL–4219, pp 87-109) REACTOR INSTRUMENTATION AND CONTROLS. (Oak Ridge National Lab., Tenn.).

Control studies and instrumentation development activities are briefly summarized. Some analog computer results of control studies for the Terrestrial Low Power Reactor concept are presented. Reactivity calculations for step-power changes from 100 to 50 MW and return in the HFIR are illustrated. Neutron density fluctuations and control rod vibrations are compared for the HFIR, and the fluctuation spectrum as a result of rod-bearing failure is presented. A conductivity-type level indicator developed for the MSRE fuel distillation system is described, and the indicator signal output versus level is illustrated. (H.D.R.)

22859 (TRG-Report–1204(Pt.1)) AN INVESTIGATION INTO THE STRUCTURAL BEHAVIOUR AND SAFETY OF A SPHERICAL PRESTRESSED CONCRETE PRESSURE VESSEL. PART 1. MAIN TEXT. Baker, A. L. L.; Moncrieff, M. L. A.; Davidson, I.; Waters, T. C.; Barrett, N. T. (United Kingdom Atomic Energy Authority, Risley (England). Reactor Group). 1966. Reprinted 1967. 63p. Dep. CFSTI. UK 11s. 0d.

The design, construction, instrumentation and testing of a 1:11.5 scale model of a reactor pressure vessel, and the associated control tests are described. The prototype vessel, designed by the UKAEA, was of the type known as a six-panel ribbed sphere. The test program was designed to investigate the structural behavior of the vessel under pressure and temperature loading, both short- and long-term. Predictions of elastic behavior, made by the "dynamic relaxation" method, were found to agree well with measured results for short-term temperature and pressure loading. Difficulties were encountered when trying to predict the long-term behavior of the vessel, and a comparison with measured results could only be obtained by using an "equivalent hollow sphere" concept. On this basis, agreement was good. The tests increased knowledge of the long-term behavior of the vessel. The vessel was subjected to the design pressure and a temperature cross-fall that was more than four times the design value. The cracks that appeared were not of excessive width, and closed when the load was removed. The rubber lining failed during the final cold pressure test, on the appearance of a shear failure at the rib-panel junction, when the load factor was 1.9. The margin between distress and this failure was 150 lb/in^2, and it seems probable that an adequate but smaller margin existed between lining failure and fracture of the cables. (auth)

22860 (TRG-Report–1204(Pt.2)) AN INVESTIGATION INTO THE STRUCTURAL BEHAVIOUR AND SAFETY OF A SPHERICAL PRESTRESSED CONCRETE PRESSURE VESSEL. PART 2. APPENDIX A. Baker, A. L. L.; Moncrieff, M. L. A.; Davidson, I.; Waters, T. C.; Barrett, N. T. (United Kingdom Atomic Energy Authority, Risley (England). Reactor Group). 1966. Reprinted 1967. 173p. Dep. CFSTI. UK 18s. 0d.

Results of tests designed to investigate the short-term and long-term structural behavior of the reactor vessel model under pressure and temperature loading are presented. (H.D.R.)

22861 (TRG-Report–1204(Pt.3)) AN INVESTIGATION INTO THE STRUCTURAL BEHAVIOUR AND SAFETY OF A SPHERICAL PRESTRESSED CONCRETE PRESSURE VESSEL. PART 3. APPENDICES B, C AND D. Baker, A. L. L.; Moncrieff, M. L. A.; Davidson, I.; Waters, T. C.; Barrett, N. T. (United Kingdom Atomic Energy Authority, Risley (England). Reactor Group). 1966. Reprinted 1967. 52p. Dep. CFSTI. UK 7s. 0d.

The instrumentation used, construction and tensioning procedures, and testing methods in the investigation of the behavior of a scale-model prestressed concrete reactor pressure vessel are presented. (H.D.R.)

22862 (TRG-Report–1204(Pt.4)) AN INVESTIGATION INTO THE STRUCTURAL BEHAVIOUR AND SAFETY OF A SPHERICAL PRESTRESSED CONCRETE PRESSURE VESSEL. PART 4. APPENDIX E. Baker, A. L. L.; Moncrieff, M. L. A.; Davidson, I.; Waters, T. C.; Barrett, N. T. (United Kingdom Atomic Energy Authority, Risley (England). Reactor Group). 1966. Reprinted 1967. 53p. Dep. CFSTI. UK 7s. 0d.

The steps taken in the attempt to predict the long-term temperature behavior of a spherical concrete vessel are described. A dynamic-relaxation approach was used to solve the problem of a simple load applied to the complex structure, and a temperature-stress computer program was used to analyze a complex load sequence applied to an "equivalent hollow sphere" concept. The program used is described. (H.D.R.)

22863 (TRG-Report–1204(Pt.5)) AN INVESTIGATION INTO THE STRUCTURAL BEHAVIOUR AND SAFETY OF A SPHERICAL PRESTRESSED CONCRETE PRESSURE VESSEL. PART 5. APPENDIX F. Baker, A. L. L.; Moncrieff, M. L. A.; Davidson, I.; Waters, T. C.; Barrett, N. T. (United Kingdom Atomic Energy Authority, Risley (England). Reactor Group). 1966. Reprinted 1967. 47p. Dep. CFSTI. UK 8s. 0d.

Data on concrete mix design and testing and prestressing cable specifications for the reactor vessel scale model are presented. (H.D.R.)

22864 (TRG-Report–1204(Suppl.1)) AN INVESTIGATION INTO THE STRUCTURAL BEHAVIOUR AND SAFETY OF A SPHERICAL PRESTRESSED CONCRETE PRESSURE VESSEL. FIRST SUPPLEMENT. ULTIMATE TEST. Baker, A. L. L.; Moncrieff, M. L. A.; Davidson, I.; Waters, T. C.; Barrett, N. T. (United Kingdom Atomic Energy Authority, Risley (England). Reactor Group). 1966. Reprinted 1967. 20p. Dep. CFSTI. UK 7s. 0d.

The results of the ultimate test performed on a 1:11.5 scale model of a spherical prestressed concrete pressure vessel are given. The vessel yielded at a pressure of 630 lb/in^2 inside the vessel; cracks in Panels B and D were $\frac{1}{32}$ and $\frac{3}{4}$ in. wide respectively at their maximum widths. (auth)

22865 (WAPD-T–2122) USE OF THE COMPUTER IN CRITICALITY STUDIES. Jones, L. L. Jr. (Bettis Atomic Power Lab., Pittsburgh, Pa.). Feb. 1968. Contract AT(11-1)-Gen-14. 25p. (CONF-680312–1). Dep. CFSTI.

From Seminar on Nuclear Criticality Safety, Pittsburgh, Pa.

The use of neutron diffusion and transport theory computer programs to determine criticality control parameters for nuclear reactors and fuel processing and handling is discussed. Three examples of the application of computer programs for criticality studies include: one and two-dimensional diffusion theory programs; and a three-dimensional MONTE CARLO program. (D.C.C.)

22866 (WAPD-TM–726) ELASTIC ANALYSIS OF THERMAL GRADIENT BOWING IN ROD-TYPE FUEL ELEMENTS SUBJECTED TO AXIAL THRUST (LWBR/LSBR DEVELOPMENT PROGRAM). Newman, John B. (Bettis Atomic Power Lab., Pittsburgh, Pa.). Jan. 1968. Contract AT(11-1)-Gen-14. 87p. Dep. CFSTI.

Thermal gradient bowing of rod type fuel elements can be analyzed in terms of the deflections of a precurved beam. The fundamental aspects of an analysis of axially compressed multispan beams are given. Elasticity of supports in both axial and transverse directions is considered; the technique is applicable to problems in which the axial thrust depends on the transverse deflection as well as problems with prescribed axial thrust. The formulas presented constitute the theory for a computer program of broad applicability, not only in the analysis of fuel rod bowing, but also to almost any multispan beam, particularly when the effects of axial loads cannot be neglected. 17 references. (auth)

22867 (WCAP–7072) USE OF PART LENGTH ABSORBER RODS IN WESTINGHOUSE PRESSURIZED WATER REACTORS. Wood, P. M.; Gallagher, J. M.; Mentz, R. M.; Dean, R. A. (comps.) (Westinghouse Electric Corp., Pittsburgh, Pa. Atomic Power Div.). June 1967. 33p. DTIE.

A discussion of the use of part length control rods in a reactor in addition to a normal control rod system is presented. The function of these rods, which are similar to standard control rods but have control material in only the bottom three feet, is to shape the axial power distribution and to control axial Xe oscillations. (D.C.C.)

22868 URANIUM AND PLUTONIUM FUELLED LATTICES WITH GRAPHITE AND WATER MODERATION: A COMPARISON OF EXPERIMENT AND THEORY. Fayers, F. J.; Kinchin, G. H. (Atomic Energy Establishment, Winfrith, Eng.). pp 15-26 of The Physics Problems in Thermal Reactor Design. London, British Nuclear Energy Society, 1967.

From International Conference on Physics Problems of Thermal Reactor Design, London. See CONF-670607.

The status of the comparison between theory and experiment for regular lattices in the UK is reviewed. The principal computer programmes used in this work, ARGOSY, METHUSELAH and WIMS, are identified, and in particular the salient features of the WIMS code are described. The validity of important aspects of the WIMS method is established by comparison with Monte Carlo results. Comparisons of results for graphite, light water, and heavy water moderated systems are summarized. These results consistently indicate a need to introduce an empirical correction to ^{238}U resonance integrals. (auth)

22869 STUDIES OF ANISOTROPIC NEUTRON MIGRATION. Palmedo, P. F. (Brookhaven National Lab., Upton, N. Y.). pp 79-80 of The Physics Problems in Thermal Reactor Design. London, British Nuclear Energy Society, 1967.

From International Conference on Physics Problems of Thermal Reactor Design, London. See CONF-670607.

Anisotropic neutron migration was studied in a series of Al–H_2O slab systems. Slowing down moments were measured from fission to 1.44 ev. Anisotropies in the second moment of about 8% were observed, in agreement with Monte-Carlo calculations. Measured diffusion lengths were in general not in agreement with calculated values. The experimental diffusion length anisotropies of 30 to 50% were generally higher than the calculated values. (auth)

22870 COMPARISON OF A FAST CALCULATION METHOD FOR THERMAL-GROUP CONSTANTS, EMPLOYED IN THE PROGRAMME SATAN, WITH THERMOS-LIKE CALCULATIONS AND EXPERIMENTAL DATA. Stamm'ler, Rudi J. J. (ASEA, Vasteras, Sweden); Tas, Aldert. pp 81-2 of The Physics Problems in Thermal Reactor Design. London, British Nuclear Energy Society, 1967.

From International Conference on Physics Problems of Thermal Reactor Design, London. See CONF-670607.

An outline is given of the approximate method used as the basis of the ALGOL program SATAN. Its results compared favorably with those obtained with K-7 THERMOS and MICROFLUX on clean H_2O and D_2O single-spin lattices. The reliability of the results was confirmed by a comparison with experimental data. (UK)

22871 SPATIALLY DEPENDENT NEUTRON SPECTRA IN A URANIUM SLAB. Antunez, H.; Neill, J. M.; Trimble, G. D.; Beyster, J. R. (General Atomic Div., General Dynamics Corp., San Diego, Calif.). pp 125-6 of The Physics Problems in Thermal Reactor Design. London, British Nuclear Energy Society, 1967.

From International Conference on Physics Problems of Thermal Reactor Design, London. See CONF-670607.

Neutron spectra were measured from 1 eV to 2 keV as a function of position across a 1.238-in. thick slab of depleted uranium placed between two 0.98-in. thick slabs of polyethylene loaded with boron to 5.3 wt %. The spatial variation of the measured flux around the 6.7 eV resonance in ^{238}U was examined and compared to the predictions of an S_4 transport theory calculation. The agreement was found to be reasonably good. (auth)

22872 A MONTE CARLO METHOD FOR CALCULATING AXIAL POWER DISTRIBUTION IN CLUSTER FUEL ELEMENTS. Beardwood, J. E. (Atomic Energy Establishment, Winfrith, Eng.). pp 156-7 of The Physics Problems in Thermal Reactor Design. London, British Nuclear Energy Society, 1967.

From International Conference on Physics Problems of Thermal Reactor Design, London. See CONF-670607.

The Monte Carlo computer programme P.M. is designed to investigate flux peaking at the ends of fuel elements in lattice situations. Sample results for AGR-type lattices are given. (auth)

22873 BUBBLE GROWTH RATE IN TRANSIENT BOILING. Akiyama, Mamoru; Tachibana, Fujio; Kawashima, Hiroaki (Tokyo Univ.). J. Nucl. Sci. Technol. (Tokyo), 5: 135-6(Mar. 1968).

The growth rates of bubbles under steady and unsteady power conditions were investigated by recording the growth of bubbles on exponentially heated nickel plates suspended in water under atmospheric pressure. Results are plotted and analyzed. (H.D.R.)

22874 INCIPIENT BOILING ON EXPONENTIALLY HEATED SURFACES. Tachibana, Fujio; Akiyama, Mamoru; Kawashima, Hiroaki (Tokyo Univ.). J. Nucl. Sci. Technol. (Tokyo), 5: 133-5(Mar. 1968).

The maximum attainable superheat of water in contact with a rolled nickel plate heated by an exponentially increasing electric power was measured and the results are plotted. (H.D.R.)

22875 TWO-DIMENSIONAL TURBULENT-FLOW MIXING MODEL FOR PARALLEL-FLOW ROD BUNDLES. Lowe, Phillip A. (Bettis Atomic Power Lab., West Mifflin, Pa.). Nucl. Sci. Eng., 32: 1-7(Apr. 1968).

A two-dimensional steady-state energy equation, in terms of the fluid enthalpy rise, for a nuclear reactor channel is formulated and solved. To facilitate its usefulness to the reactor designer, the solution is presented in the form of a hot-channel factor. Parametric results are presented so the information may be related to other channel dimensions. Mixing was found to be a function of the nondimensional geometry factor and the Peclet number. (auth)

22876 OPTIMAL CONTROL OF A DISTRIBUTED-PARAMETER REACTOR. Kyong, Sang Hyon (Bell Telephone Labs., Whippany, N. J.). Nucl. Sci. Eng., 32: 146-9(Apr. 1968).

A direct technique for the solution of a class of optimal control problems involving a distributed-parameter reactor is presented. The technique is applicable to general linear systems if the operator of the system has the adjoint and it avoids the two-point boundary value problem. The direct technique yields a set of simultaneous integral equations as the necessary and sufficient condition for the optimal control. A characteristic expansion method is presented for solving simultaneous Fredholm integral equations of the second kind which arise in the process of determining the optimal control. (H.D.R.)

22877 MANUFACTURE AND PROPERTIES OF REACTOR FUELS. Ermischer, Wolfgang Neue Huette, 12: 486-91(Aug. 1967). (In German).

The manufacture and properties of actual and potential reactor fuels are reviewed. A number of uranium and plutonium compounds are suitable for this purpose. At the present time, UO_2 is the most frequently used fuel; metallic uranium and uranium alloys are also used. More sophisticated reactors require fuels with better thermal conductivity and density characteristics. The relevant properties of metallic uranium, UO_2, uranium carbide, uranium nitride, and plutonium compounds, and the sintering behavior of uranium dioxide are presented. The nitride and carbide fuels require novel manufacturing, fabrication, use, and safety techniques. 21 references, including 4 German and 17 Western. (Manuscript received 11 Oct. 1966). (JPRS)

22878 ONE-VELOCITY CALCULATIONS FOR THE ANALYSIS OF REACTOR PHYSICS EXPERIMENTS. d'Oultremont, P. (Belgonucleaire, Brussels); Van Malder, M. Nucl. Sci. Eng., 32: 140-2(Apr. 1968).

Two different experiments are analyzed using a one-velocity diffusion approximation to fit the experimental data. The first experiment was the propagation of a purely thermal neutron wave in light water and observation of the perturbation of the neutron population. The second was the measurement of reactivity by the pulsed–source method in a square sub-critical H_2O–UO_2 lattice surrounded by an infinite light water reflector. (H.D.R.)

22879 AN ANALYSIS OF CONTINUOUS BI-DIRECTIONAL REACTOR REFUELING. Yasukawa, Sigeru (Japan Atomic Energy Research Inst., Ibaraki). J. Nucl. Sci. Technol. (Tokyo), 4: 367-71(July 1967).

An analysis of continuous bi-directional reactor refueling is developed by one group diffusion approximation. The fundamental integro-differential equation is first converted to second order nonlinear differential equation, which is further reconverted to first order nonlinear differential equation, to finally take the form $(du/dx)^2 = f(u)$. By applying the elliptic function theory, the analytical solution for neutron flux and eigenvalue is obtained, and their physical characteristics are examined. Numerical results for neutron flux distribution are presented for the case where the rate of fuel feed movement is not the same for the two directions. (auth)

22880 FUEL BURN-UP: A REVIEW OF EACRP ACTIVITIES. Raievski, V. (European Nuclear Energy Agency, Paris); Naudet, R.; Spinrad, B. I. pp 147-72 of Fuel Burn-up Predictions in Thermal Reactors. Vienna, International Atomic Energy Agency, 1968.

From IAEA Meeting on Fuel Burnup Predictions in Thermal Reactors, Vienna, Austria. See STI/PUB-172; CONF-670418.

For several years the European American Committee on Reactor Physics (EACRP) has been carrying out a study program on burn-up physics. V. Raievski summarizes the main conclusions of the EACRP and lists a number of unsolved problems requiring urgent attention. It emerged that the most difficult problem was to take into account the over-all situation of the reactor (calculation of flux distributions in complex situations). The EACRP therefore recommended the holding in January 1967 of two meetings of experts on calculating flux distribution by heterogeneous (well-source) and homogeneous methods; the results are analyzed by R. Naudet and B. I. Spinrad. (auth)

22881 CONTINUAL EXCHANGE OF FUEL IN A REACTOR WITH A FLAT CENTRAL ZONE. Bosevski, T.; Strugar, P.; Pop-Jordanov, J. (Boris Kidric Inst. of Nuclear Sciences, Belgrade). pp 191-202 of Fuel Burn-up Predictions in Thermal Reactors. Vienna, International Atomic Energy Agency, 1968.

From IAEA Meeting on Fuel Burnup Predictions in Thermal Reactors, Vienna, Austria. See STI/PUB-172; CONF-670418.

The flattening of thermal neutron flux in the central reactor zone can be achieved by various methods, the most convenient being a continual fuel exchange. The exchange scheme described has been chosen because it treats the equilibrium state by the analytical method. The improvement in the calculation procedure is particularly evident in natural uranium fuel reactors. (auth)

22882 USE OF COMPUTER CODES IN ESTIMATING FUEL ELEMENT FABRICATION COSTS. Lotts, A. L.; Washburn, T. N. (Oak Ridge National Lab., Tenn.). Contract W-7405-eng-26. Nucl. Appl., 4: 307-19(May 1968). (ORNL-P-3380).

Use of computer codes for calculation of capital cost and operating cost factors for fuel fabrication plants is presented. Sample input and output data are shown. The types of fuel elements, for which a fabrication cost computer program is available, are discussed. (M.L.S.)

22883 REACTOR AND FUEL-PROCESSING TECHNOLOGY. Volume 10, Number 4. Dutton, James J.; Lennox, David H.; Brown, Karl K.; Roylal, Joseph; Gold, Raymond; Gregory, Paul H. One of the Four Quarterly Technical Progress Reviews Published for the Division of Technical Information, USAEC. Argonne National Lab., Ill., Fall 1967. 69p. GPO $0.70.

Separate abstracts were prepared for the eight papers included. (D.C.W.)

For abstracts of individual papers see: 21078, 21167–21169, 21713, 22612, 22727, and 22884.

22884 AEC PROPOSES CRITERIA FOR PRESSURE VESSELS, INVITES COMMENTS. Reactor Fuel-Process. Technol., 10: 289-302(Fall 1967).

To ensure that pressure vessels for reactor systems are built to the highest practicable quality standards, the U.S. Atomic Energy Commission issued on Aug. 23, 1967, a set of 34 criteria for the design, material, fabrication, inspection and testing of such vessels. The criteria are entitled "Tentative Regulatory Supplementary Criteria for ASME Code-Constructed Nuclear Pressure Vessels," and descriptions of the criteria are presented. (auth)

22885 DEVICE FOR REGULATING THE POWER OF A NUCLEAR REACTOR. Costes, D.; Lebey, J. (to Commissariat a l'Energie Atomique). Canadian Patent 777,283. Jan. 30, 1968. Priority date June 25, 1963, France.

The control device is made of a single chain or several chains side by side which are inserted in the reactor core when the reactivity requires adjustment. The chain links are made of neutron absorbing material and are stored either in the channel above or below the reactor core. If stored below a cable and winch pull the chain upwards; if stored above the chain is lowered by a sprocket wheel. (F.S.A.)

22886 METHOD AND APPARATUS FOR NUCLEAR REACTIVITY REDUCTION. Courtemanche, R.; Bigham, C. B. (to Atomic Energy of Canada Ltd.). Canadian Patent 774,688. Dec. 26, 1967.

A method is described for reducing the initial reactivity of slightly enriched ^{235}U fuel by dispersing calculated amounts of Gd, Sm or Cd as neutron absorbers in the fuel or its sheath. After relatively short exposure to high neutron flux in the reactor, these added impurities cease to inhibit the normal reactivity. Such treatment eases criticality problems during fabrication and prevents a sudden increase in reactivity when new fuel is added with the reactor at power. When fuel is to be shifted from a zone of higher to one of lower reactivity, it may be advantageously removed for several hours. The Xe poison will reduce the normal reactivity temporarily thus preventing an initial surge on reinsertion in the second zone. (F.S.A.)

22887 INTERNAL PRESSURIZATION OF A NUCLEAR REACTOR OF THE PRESSURIZED WATER TYPE. McHugh, B. (to Aktiebolaget Atomenergi). Canadian Patent 774,690. Dec. 26, 1967.

A pressure vessel contains nuclear fuel and water in its lower portion and a space above, referred to as a surge tank. Between the two is a thermal barrier of special construction with some openings to allow water movement upward due to expansion on heating. Connected to the surge tank is a source from which superheated steam may be admitted to prevent boiling in the surge tank. A nozzle is also provided in this tank through which cold water may be sprayed to prevent bulk boiling. With suitably placed valves it is claimed that pressure may be controlled without much heat loss from the reactor. Control rods are introduced through the thermal barrier. (F.S.A.)

22888 FUEL RODS FOR NUCLEAR REACTORS. Alfille, L. (to European Atomic Energy Community). Cansdian Patent 771,280. Nov. 7, 1967. Priority date June 20, 1962, Belgium.

A fuel element is described for use in a reactor cooled by pressurized fluid and using natural or very slightly enriched, U slugs. The stainless steel sheath of about 0.05 mm thickness has lengthwise corrugations and circular folds about its ends which permit easy deformation. Between the sheath and the fuel is a layer of Mg about 0.5 mm thick which is plastic at the operating temperature of about 550°C. Procedure is given for introducing the Mg filler into the sheath prior to insertion of the fuel slugs. Fission gases may collect in the folds and the thin sheath allows for dimensional changes with good heat transfer and neutron economy. (F.S.A.)

GENERAL

22889 (AEEW-M-749) FIXED DIODE FUNCTION GENERATING EQUIPMENT. Kingdon, F. C. (Atomic Energy Establishment, Winfrith (England)). Nov. 1967. 12p. Dep. CFSTI, UK.

The system developed for the generation of arbitrary functions of computed variables to be used in conjunction with the PACE analog computer is described. It is intended to give sufficient detail to allow programmers to build up functions for themselves. (auth)

22890 (BNL-12279) AUTOMATIC GENERAL SOLUTIONS TO ALL-INTEGER INEQUALITIES. Jenks, Richard D. (Brookhaven National Lab., Upton, N. Y.). Feb. 1968. 32p. Dep. CFSTI.

Automatic methods for obtaining general integer-valued solutions to $Ax \geq b$, $x \geq 0$, where A is a given integer-valued $(n \times m)$-matrix and b is a given m-vector are analyzed. An algorithm having alternative two-way splitting rules is presented. Also, the fundamental theorem for the case $Ax = b$ is stated. (W.H.K.)

22891 (DP-1127) ASP; ANALYSIS OF SYNTHETICS PROGRAM FOR QUALITY CONTROL DATA. Bailey, L. V.; Arnett, L. M. (Du Pont de Nemours (E. I.) and Co., Aiken, S. C. Savannah River Lab.). Jan. 1968. Contract AT(07-2)-1. 15p. Dep. CFSTI.

The computer program, ASP, which calculates bias, precision, and other statistics of analytical methods, was written in FORTRAN IV for use on the IBM System/360-65. The Savannah River Plant laboratories use ASP monthly and quarterly to evaluate and to report the bias and precision of analyses important to process control and accountability. (auth)

22892 (HIG-67-11) LOW-FREQUENCY WAVE STUDY IN THE MESO-DEEP OCEAN. Final Report. Vitousek, Martin J.; Miller, Gaylord R. (Hawaii Univ., Honolulu. Hawaii Inst. of Geophysics). July 1967. Contract AT(26-1)-235. 17p. (NVO-235-2). Dep. CFSTI.

Instrumentation for recording low-frequency waves in deep water off the Kona coast of the island of Hawaii was installed and maintained. The signals were recorded in the existing AEC data acquisition system. The equipment, installation procedure, and environment are described in detail. One Vibrotron pressure transducer was installed at 90 fathoms, a second at 288 fathoms. Both met the design criterion of being able to record the actual very-low noise level of the ocean. (L.C.L.)

22893 (K-1740) COMPUTER PROGRAM TO SOLVE EDDY-CURRENT PROBLEMS. Tunstall, J. Nelson; Dodd III, C. V. (Oak Ridge Gaseous Diffusion Plant, Tenn.). Apr. 8, 1968. Contract W-7405-eng-26. 63p. Dep. CFSTI.

The partial differential equation $\Delta A - A/r^2 = -\mu\iota + i\omega\mu\sigma A - \mu\{[\partial(1/\mu)/\partial r][(1/r)(\partial rA/\partial r)] + [\partial(1/\mu)/\partial z](\partial A/\partial z)\}$, where Δ is the differential operator $\Delta = \partial^2/\partial r^2 + [(1/r)(\partial/\partial r)] + \partial^2/\partial z^2$ and $A = A(z,r)$, with fixed boundary conditions is considered. A numerical technique of solution and a description of a computer code which uses this technique are presented. This equation arises from considering Maxwell's equations in a conductive, isotropic, inhomogeneous medium at low frequencies and assuming symmetry about the axis of the coil and a sinusoidal driving current. (auth)

22894 (K-L-6183) IMPROVED TECHNIQUES FOR CORROSIVE FLUORIDE GAS CHROMATOGRAPHY. Pappas, W. S.; Million, J. G. (Oak Ridge Gaseous Diffusion Plant, Tenn.). [1968]. Contract W-7405-eng-26. 14p. (CONF-680308-6). Dep. CFSTI.

From 155th National Meeting of the American Chemical Society, San Francisco, Calif.

Several new techniques are described which broaden the applicability of gas chromatography to corrosive fluoride gases. Columns prepared with Teflon-6 support were applied. A new column utilizing fluorocarbon oil instead of the conventional chlorofluorocarbon oil as the liquid phase is described, with application to inorganic and organic fluorine compounds. The loss of small amounts of certain reactive fluoride gases was found due principally to sorption on system surfaces, rather than on the column packing. Replacement of metal tubing with Teflon tubing reduced sorption losses, markedly improving detectability limits for these constituents. A two-step column technique sped up analysis, without fraction storage, when late eluders were present. (auth)

22895 (LA-3846) FILM-IMAGE-SYNCHRONIZED DRUM CAMERA SYSTEM FOR PROJECTILE-IN-FLIGHT PHOTOGRAPHY. Giles, Paul M. (Los Alamos Scientific Lab., N. Mex.). Jan. 1968. Contract W-7405-eng-36. 8p. Dep. CFSTI.

Projectile-in-flight field photography has been simplified by development of a film-image-synchronized drum camera system. This system has the following advantages: carry-on weight and setup time are reduced; film consumption and processing time are reduced; in-field film loading and reloading, and use of field power and control drop lines are eliminated; and accuracy of film-to-image synchronism is increased. (auth)

22896 (LA-3874) STOP-MOTION FLASH PHOTOGRAPHY OF PROJECTILES IN FLIGHT. Giles, Paul M. (Los Alamos Scientific Lab., N. Mex.). Jan. 1968. Contract W-7405-eng-36. 12p. Dep. CFSTI.

Stop-motion photography of projectiles in flight is a practical method for evaluating artillery weapon components by high resolution pictures when rotational distortion cannot be tolerated. (auth)

22897 (LA-3875) REACTION KINETICS IN CONCENTRATION SPACE. Everett, C. J. (Los Alamos Scientific Lab., N. Mex.). Jan. 1968. Contract W-7405-eng-36. 17p. Dep. CFSTI.

A "global" view of a reversible reaction governed by the law of mass action is obtained by regarding all its possible histories as trajectories in a space of concentrations. Processes at constant volume and pressure are studied in some detail. The picture obtained is one of a space separated into two components by a hypersurface of equilibrium points, toward which all points of these components flow, on a family of trajectories simply covering the space. (D.L.C.)

22898 (MLM-1440) REACTION BETWEEN EPOXIDES AND BOROXINES. Matta, M. S. (Mound Lab., Miamisburg, Ohio). Aug. 29, 1967. Contract AT-33-3-GEN-53. 17p. Dep. CFSTI.

The reactions of epoxides with trialkyl and trialkoxy boroxines of varied substitution were studied to clarify the foam producing reaction of trimethoxyboroxine with vinyl cyclohexene dioxide. Epoxides whose oxirane ring open to secondary carbonium ions formed only polymeric products, and those which open to tertiary or benzylic carbonium ions formed mixtures of polymerization and isomerization products. A thorough examination of the products of reactions employing epoxides and boroxines of varying molecular structure provided information on the pathway by which Lewis acids promote epoxide polymerization. Also, the role of boroxines as Lewis acid catalysts was investigated. No attempt was made to acquire quantitative data because the purpose of these experiments was exploratory. (auth)

22899 (ORNL-4225) PART 1. THE LIMITING DISTRIBUTION OF THE LIKELIHOOD RATIO STATISTIC $^{2}n\lambda_n$ UNDER A CLASS OF LOCAL ALTERNATIVES. PART 2. MINIMUM AVERAGE RISK DECISION PROCEDURES FOR THE NONCENTRAL χ-SQUARE DISTRIBUTION. Lever, William Edwin (Oak Ridge National Lab., Tenn.). Mar. 1968. Contract W-7405-eng-26. 145p. Dep. CFSTI.

Thesis. Submitted to Florida State Univ., Tallahassee.

Critical values are given for two minimum average risk decision procedures with the following respective decision regions: (1) $\{\lambda | 0 \leq \lambda < \tau\}$ or $\{\lambda | \tau \leq \lambda < \infty\}$ and (2) $\{(\lambda_1,\lambda_2) | E(\lambda_1|U_1) < E(\lambda_2|U_2) + \tau\}$ or $\{(\lambda_1,\lambda_2) | E(\lambda_1|U_1) \geq E(\lambda_2|U_2) + \tau\}$, where U, U_1, and U_2 are random variables with noncentral chi-square distributions with S, S_1, and S_2 degrees of freedom and noncentrality parameters λ,λ_1, and λ_2, respectively, where $0 \leq \lambda, \lambda_1, \lambda_2 \leq \infty$. These critical values are determined for the case when the loss function is a linear regret function and the noncentrality parameter has a gamma distribution. These decision procedures are extended by the use of the Restricted Product method of Lehmann to give several multiple decision procedures involving several independent noncentral chi-square random variables. When the noncentrality parameter has a gamma distribution and the posterior distribution of the noncentrality parameter is to be used for the prior distribution of a future experiment, a way of approximating the posterior distribution by a gamma distribution is considered. This approximation is made so that the same set of critical values can be used for each experiment. To aid the experimenter in determining his sample size, an approximate method for determining an optimum sample size, that is, the sample size which approximately minimizes a specified cost function, is provided. The cost functions were formulated under the assumption that the loss function is a linear regret function and that the prior distribution of the noncentrality parameter is a gamma distribution. To provide a larger area of possible application, it is shown that under certain conditions, the decision procedures could be applied to a

random variable which has only an asymptotic noncentral chi-square distribution. The decision procedures discussed in this paper are mainly decision procedures on a distance function which will usually measure the distance between the parameters or a subset of the parameters of a distribution under question and a standard distribution. Two such applications are given, one involving a noncentral chi-square distribution exactly, the other only asymptotically. (auth)

22900 (ORNL-TM-2142) FORTRAN INPUT/OUTPUT FOR TAPES AND DIRECT ACCESS DEVICES. Sullivan, J. G. (Oak Ridge National Lab., Tenn.). Feb. 29, 1968. Contract W-7405-eng-26. 81p. Dep. CFSTI.

The flexibility of the new IBM system practically requires the programmer who has any need for extensive input–output use to develop an understanding of the devices, the facilities available to him, and the consequences involved with choices only he can rationally make. The relevant input–output devices on the ORNL 360/75 and the control facilities available to the programmer are described, and some guides to efficient use of the devices are presented. (W.H.K.)

22901 (ORO-2733-13) CHEMISTRY OF THE METALLOIDS OF GROUP VA AND GROUP VIA. Progress Report, January 1–December 31, 1967. Zingaro, Ralph A. (Texas Agricultural and Mechanical Univ., College Station. Dept. of Chemistry). Contract AT(40-1)-2733. 23p. Dep. CFSTI.

The formation constants and thermodynamic data were measured for complexes formed between trisubstituted phosphine selenides and iodine. The results are consistent with the stronger donor capabilities predicted for phosphine selenides. A computer program for vibrational analysis of polyatomic molecules was tested. Reactions of some organophosphorus compounds with alkali metals in tetrahydrofuran and the free radicals formed are being investigated by ESR spectroscopy. An improved analytical method for the determination of arsenic in organic compounds was developed. The organic compound is digested with fuming nitric acid and hydrogen peroxide is added. Arsenic is then determined by the iodometric method. Branched-chain arsinic and arsonic acids and derivatives of these acids containing unsaturated substituents were prepared. When H_2S was bubbled, at room temperature, through a concentrated solution of dimethylarsinic acid in ethanol the product obtained was $(CH_3)_4As_2S_2$. In the synthesis of compounds of the general type R_2AsOH, two intermediates were produced. R_3SbO, where R is butyl, propyl, or amyl radicals, was prepared. Mineral acid extraction by di-n-octylarsinic acid was studied. Heats of fusion and of transition of the C_1 to C_{20} arsinic acids are discussed as a basis for postulating molecular structure of these molecules. (M.C.G.)

22902 (PRNC-104, pp 24-53) DIURNAL VARIATION IN ZOOPLANKTON ABUNDANCE, SPECIES COMPOSITION, AND ELEMENTAL CONTENT. (Puerto Rico Nuclear Center, Mayaguez).

Total zooplankton was sampled every other hour at the water's surface during a day and night. Chemical analyses, measurements of total numbers of organisms, wet weight, dry weight, and species composition were performed. The zooplankton consisted of copepods, chaetognaths, decapod larvae, pteropods, and siphonophores. The total number of individuals per cubic meter of sea water increased through the daylight hours and reached a maximum at sunset. Numbers then decreased steadily until midnight, increased again before dawn and diminished thereafter. The organisms were analyzed for concentrations of C, H, N, Ca, Cd, Co, Cu, Fe, Mg, Mn, Ni, Pb, Sr, and Zn. (H.L.W.)

22903 (PRNC-104, pp 57-67) STUDY OF STABLE ELEMENTS IN MARINE ORGANISMS. (Puerto Rico Nuclear Center, Mayaguez).

Samples of aquatic organisms were collected for stable element analysis. The concentrations of cadmium, calcium, cobalt, copper, iron, lead, magnesium, manganese, nickel, phosphorus, scandium, strontium, and zinc were determined in crustaceans, mollusks, bottom fish, pelagic fish, and algae. Computer programs are included for analysis of variance techniques. (H.L.W.)

22904 (PRNC-104, pp 90) PLANT NUTRIENT MEASUREMENTS. (Puerto Rico Nuclear Center, Mayaguez).

As part of the primary productivity studies in western Puerto Rico waters, preliminary plant nutrient measurements were begun. Colorimetric techniques are being used for the determination of soluble iron and phosphate while surveys of the concentration of nitrogen and silicate will begin shortly. In addition to the plant nutrient concentrations, temperature and salinites are also being observed. (H.L.W.)

22905 (RD/B/M-1032) A PHILIPS EM200 ELECTRON MICROSCOPE HOLDER FOR FIELD ION MICROSCOPE SPECIMENS. Buswell, J. T.; Rickards, G. K. (Central Electricity Generating Board, Berkeley (England). Berkeley Nuclear Labs.). Feb. 1968. 6p. Dep.

A holder was constructed for examining field ion microscope specimens by transmission electron microscopy in a Philips EM200 Electron Microscope. The design of the holder also enables the field ion tips to be irradiated in an ion accelerator in directions parallel to, or perpendicular to, the tip axis. (auth)

22906 (RISO-M-707) HANDLING OF COMMON SUB-ROUTINES IN A SMALL COMPUTER MULTIPROGRAMMED SYSTEM (PDP 8/DR 2 SYSTEM). Goodstein, L. P. (Danish Atomic Energy Commission, Risoe, Research Establishment). Feb. 1968. 11p. (R-8-68). Dep.

The problem of shared sub-routines in a multi-programming environment is treated. Emphasis is placed on the possibilities which exist for handling these sub-routines in a system incorporating a small PDP 8 computer. (auth)

22907 (SC-CR-68-3418) FLUIDYAMICAL INFLUENCES ON STAGNATION POINT HEAT TRANSFER RATES FOR MODELS IMMERSED IN FREE JETS. Dahm, Thomas J. (Aerotherm Corp., Palo Alto, Calif.). Nov. 1966. Contract AT(29-1)-789; Subcontract 48-4862. 29p. Dep. CFSTI.

The stagnation point heat flux behavior for a model situated in the exhaust stream of an arc tunnel or other high temperature gas source is considered. The influences of test condition, model size and stream size on heat flux are examined on a general basis. Requirements and constraints to achieve "infinite stream" conditions in a "finite stream" are developed. (auth)

22908 (SC-CR-68-3521) STUDIES OF SOLUTE-SOLVENT INTERACTIONS IN NON-AQUEOUS SOLVENTS. Period Covered: July 1, 1967–January 15, 1968. Vanderborgh, N. E.; Spall, W. D. (New Mexico Univ., Albuquerque). Contract AT(29-1)-789; Subcontract 53-6574. 66p. Dep. CFSTI.

For Sandia Corp., Albuquerque, N. Mex.

Ultrasonic apparatus was constructed and experiments were carried out to determine the equilibrium constants for association of various phenols in low-dielectric constant nonaqueous solvents. Phenol, nitrophenol, and chlorophenol dissolved in cyclohexane, carbon tetrachloride, and benzene were studied. (M.C.G.)

22909 (SC-CR-68-3520) INVESTIGATION OF ORGANIC THERMOCHROMIC MATERIALS. West, B. D. (New Mexico Univ., Albuquerque. Dept. of Chemistry). Feb. 1968. Contract AT(29-1)-789; Subcontract 53-6574. 11p. Dep. CFSTI.

For Sandia Corp., Albuquerque, N. Mex.

The chemical change in 3,5-diphenylimidazoline-4 responsible for its thermochromism was studied and analogous materials were prepared. The presence of a strong base shifted the thermochromic phenomenon of these compounds to lower temperatures. (M.C.G.)

22910 (SC-DC-68-2077) AEROELASTIC STABILITY CHARACTERISTICS OF CYLINDRICAL SHELLS CONSIDERING IMPERFECTIONS AND EDGE CONSTRAINT. Barr, Gerald W. (Sandia Corp., Albuquerque, N. Mex.); Stearman, Ronald O. (Texas Univ., Austin). Feb. 1968. Contract AT(29-1)-789. 10p. (CONF-680407-2). DTIE.

From AIAA/ASME 9th Structures, Structural Dynamics, and Materials Conference, Palm Springs, Calif.

Recent wind tunnel results indicate that the existing cylindrical shell aeroelastic stability theories are generally nonconservative. Therefore, some type of destabilizing mechanism is needed in the present theory to enhance correlation with experiment. The dynamic stability behavior of thin circular cylindrical shells subjected to a supersonic flow field is investigated theoretically and compared with existing experimental data. Combined effects of axisymmetric initial geometric imperfections, radial edge constraint, and prestability deformations are considered. The cylinder's motion is described with nonlinear Donnell type shell equations coupled with a linear "piston theory" aerodynamic approximation. A modal type approach employing Galerkin's approximate technique is used to investigate the dynamic stability about the shell's deformed middle surface. Prestability deformations alone have been shown to have very little influence on the aeroelastic stability behavior of very thin shells. However, with the inclusion of initial imperfections, the combined effect is destabilizing. The resulting aeroelastic stability boundaries correlate quite well with existing experimental data. (auth)

22911 (SC-R-67-1271) ENVIRONMENTAL ENGINEERING ABSTRACTS. (Sandia Corp., Albuquerque, N. Mex.). Dec. 15, 1967. Contract AT(29-1)-789. 18p. Dep. CFSTI.

A bibliography which contains 60 references to published literature on environmental engineering is presented. (L.C.L.)

22912 (SC-R-68-1650) ENVIRONMENTAL ENGINEERING ABSTRACTS. (Sandia Corp., Albuquerque, N. Mex.). Jan. 15, 1968. Contract AT(29-1)-789. 18p. Dep. CFSTI.

A bibliography which contains 61 references to published literature on environmental engineering is presented. (L.C.L.)

22913 (SCL-DC-67-80) LABORATORY MANUAL: A FABRICATION PROCESS FOR CLOSE-TOLERANCE, MULTILAYER, PRINTED-WIRING BOARDS. Andrade, A. D. (Sandia Corp., Livermore, Calif.). Feb. 1968. Contract AT(29-1)-789. 94p. Dep. CFSTI.

A step-by-step outline of a technique used in the fabrication of multilayer printed-wiring boards is given. The process produces low-cost, close-tolerance, reliable boards; and does it by making maximum utilization of the advanced numerically controlled equipment that is now becoming available. (auth)

22914 (SCL-DR-68-11) FAST-RISE PULSED SOLID-STATE INJECTION LASER SYSTEM. Stull, J. W.; Miller, R. L. (Sandia Corp., Livermore, Calif.). Apr. 1968. Contract AT(29-1)-789. 28p. Dep. CFSTI.

A pulsed, laser system is described for producing fast-rise, intense, coherent light pulses at 9000 Angstroms. This light is suitable for testing silicon photo devices or any other photo device with an S1-type of response. (auth)

22915 (TID-5001(7th Rev.)) SUBJECT HEADINGS USED BY THE USAEC DIVISION OF TECHNICAL INFORMATION. Upchurch, Robert E. (ed.) Division of Technical Information Extension (AEC), Oak Ridge, Tenn.). Apr. 1968. 248p. Dep. CFSTI.

The subject heading authority used by the Division of Technical Information Extension (DTIE) as an information indexing and retrieval tool in preparing subject indexes to the literature abstracted in Nuclear Science Abstracts and in searching these indexes either by manual or machine-assisted means is presented. (B.G.D.)

22916 (TID-24309) STRESS ANALYSIS FOR A SPHERICAL SHELL PERFORATED BY MANY RADIAL HOLES. Report No. 118. Rung, Robert; Salerno, Vito L. (Applied Technology Associates, Inc., Ramsey, N. J.). Jan. 1968. Contract W-7405-eng-26; Subcontract 2752. 42p. Dep. CFSTI.

A point-matching method using assumed functional forms for the Airy stress function is applied to the two-dimensional problem of closely spaced holes in a regular triangular pattern. Compatibility is satisfied at discrete points in the field and boundary conditions and are also specified at particular points. The method is extremely sensitive numerically and is not considered suitable for calculations for analysis and design parametric studies. (auth)

22917 (TID-24326) THE ARITHMETIC SUBSYSTEM OF THE NEW ILLINOIS COMPUTER. Report No. 160. Penhollow, J. O. (Illinois Univ., Urbana. Digital Computer Lab.). Jan. 24, 1964. Contract AT(11-1)-415. 246p. Dep. CFSTI.

A comprehensive description of the logical structure and function of the Arithmetic Subsystem of the new Illinois computer is presented. The description was written for those with maintenance responsibilities. Topics include the arithmetic unit, link mechanisms, and delayed control. (B.G.D.)

22918 (UCID-15264) CONVERSATIONAL FOURIER ANALYSIS. McCall, J. R.; Frerking, C. E. (California Univ., Livermore. Lawrence Radiation Lab.). Feb. 20, 1968. Contract W-7405-eng-48. 57p. Dep. CFSTI.

The program FOURIER is a general Fourier analysis code written for the LRL 6600 computers, allowing a user to direct the course of data handling through a conversation with the machine. The user may sit at a teletype and ask for operations such as data compression, Fourier analysis, and plotting and printing of Fourier coefficients. From the teletype the user requests a subroutine and provides it with the necessary arguments. Each available operation and its application and method of computation is discussed. (auth)

22919 (UCRL-17878(Rev.)) ARC SPECTRUM OF MAGNESIUM OXIDE. Green, David W. (California Univ., Berkeley. Lawrence Radiation Lab.). Feb. 1968. Contract W-7405-eng-48. 62p. Dep. CFSTI.

Thesis. Part II.

A comparison of the observed molecular electronic states of magnesium oxide is made to the states predicted by theoretical considerations. The observations reported are incomplete and considerable uncertainty exists about the states below 10 kK (10,000 cm^{-1}). Low-lying triplet states were predicted on the basis of atomic states of the separated atoms and semiempirical molecular orbital considerations. Assignments were made to a number of observed but previously unassigned band heads in the violet spectrum of MgO. The (0,0) sequences of the $C^1\Sigma^- - A^1$ and $D^1\Delta - A^1\Pi$ transitions as well as the (0,1) sequence of the $D^1\Delta - A^1\Pi$ were observed in the arc spectrum of magnesium oxide. Additional band systems with sequences beginning at 3672 and 3637 Å were observed and measured. Band heads were observed in the region from 2600 to 2800 Å which cannot be attributed to a known transition. The possible assignment of the C and D states of magnesium oxide to triplets was considered. Relative intensities of the violet, green and red band systems of MgO are reported. Second differences for the C and D states were calculated from the previously reported rotational lines. Intensity calculations were performed for the branches of a $^3\Sigma - ^3\Pi$ electronic transition with the $^3\Pi$ state intermediated between Hund's coupling cases (a) and (b). No clear conclusions were drawn about the location of electronic triplet states in the MgO molecule. (auth)

22920 (UCRL-18111) A PRACTICAL APPROACH TO EMI PROBLEMS. Hartley, C. Marvin (California Univ., Berkeley. Lawrence Radiation Lab.). Feb. 28, 1968. Contract W-7405-eng-48. 5p. (CONF-680303-1). Dep. CFSTI.

From Noise Reduction Conference, Livermore, Calif.

Mysteries associated with electromagnetic interference disappear when correct procedures are used to solve noise problems. Many problems are caused by faults in the troubled equipment itself that make it sensitive to ever-present ambient noises. The first step in a practical approach toward a noise problem must include an inspection of the affected system. When extraneous noise is at fault the source is usually found in the immediate area. (auth)

22921 (UCRL-50354(Pt.1)) A GLOBAL NUMERICAL OCEAN MODEL. Crowley, W. P. (California Univ., Livermore. Lawrence Radiation Lab.). Nov. 16, 1967. 40p. Dep. CFSTI.

A numerical model of the world oceans based on the primitive equations is described. The model ocean extends from 60° south to 60° north and is global in longitude. Continental boundaries are approximated by connecting mesh points with straight lines. For horizontal motions, the resolution allowed by the mesh is 5 deg. The vertical structure consists of six unevenly spaced layers which vary in size from 0.05 km at the surface to 0.8 km at the bottom. Bottom topography is ignored, but a free upper surface permits the existence of external gravity waves. There are five prognostic variables (temperature, salinity, surface height anomaly, and two horizontal velocity components) which are functions of the four independent variables (latitude, longitude, depth, and time). Diagnostic variables are density anomaly, pressure, and vertical velocity. These are determined from the prognostic variables through an equation of state and the assumptions of hydrostatic equilibrium and incompressibility. (auth)

22922 (AEC-tr-6812) NUKLEONIKA. Translation of Nukleonika, 12: 175-262(1967). 84p. Dep. CFSTI.

22923 (AEC-tr-6813) NUKLEONIKA. Translation of Nukleonika, 12: 263-346(1967). 77p. Dep. CFSTI.

22924 (AEC-tr-6814) NUKLEONIKA. Translation of Nukleonika, 12: 347-94(1967). 45p. Dep. CFSTI.

22925 MAJOR ACTIVITIES IN THE ATOMIC ENERGY PROGRAMS, JANUARY-DECEMBER 1967. Washington, D. C., Atomic Energy Commission, 1968. 408p. $1.50. (TID-24295). GPO.

Topics discussed include: ore processing and special nuclear materials; safeguards and materials management; the nuclear defense effort; naval propulsion reactors; reactor development and technology; licensing and regulations; operational safety; nuclear rocket propulsion; specialized nuclear power units; isotopic radiation applications; the Plowshare program; nuclear education and training; basic research; industrial participation aspects; and administrative and management matters. (D.C.C.)

Appendix I

JOURNAL LIST

The following list includes 1968 additions to the comprehensive list published in NSA, Volume 22, No. 1, January 15, 1968. In the future, comprehensive lists will be published once each year (in January), and current additions will be cumulated on a monthly basis (in alternate issues) until the next comprehensive list is issued.

The title abbreviations are based on the United States of America Standards Institute's REVISED AND ENLARGED WORD-ABBREVIATION LIST FOR USASI Z39.5–1963 AMERICAN STANDARD FOR PERIODICAL TITLE ABBREVIATIONS. Titles of journals that are scanned regularly for NUCLEAR SCIENCE ABSTRACTS are marked by an asterisk (*). Foreign-language journals identified by a dagger (†) are available in English translation. The original-language title for a translated journal is given in parenthesis after the English title.

Acta Anat. Nippon.
Acta Anatomica Nipponica
see Kaibogaku Zasshi

Acta Astron.
Acta Astronomica, Polska Akademia Nauk (formed by merger of Acta Astronomica, Ser. A; Ser. B; and Ser. C) *(Poland)*

Acta Entomol. Bohemoslov.
Acta Entomologica Bohemoslovaca *(Czechoslovakia)*

Acta Med. Iugoslav.
Acta Medica Iugoslavica *(Yugoslavia)*

Acta Pharm. Hung.
Acta Pharmaceutica Hungarica *(Hungary)*

Acta Pharm. Suec.
Acta Pharmaceutica Suecica *(Sweden)*

Acta Phys. Chem.
*Acta Physica et Chemica *(Hungary)*

Acta Polytech., Chem. Met. Ser.
Acta Polytechnica, Chemistry including Metallurgy Series *(Sweden)*

Acta Sci. Natur. Univ. Pekin.
Acta Scientiarum Naturalium Universitatis Pekinensis
see Pei Ching Ta Hsueh Hsueh Pao, Tzu Jan K'o Hsueh

Acta Univ. Nankinensis Sci. Natur.
Acta Universitatis Nankinensis Scientiarum Naturalium
see Nan Ching Ta Hsueh Hsueh Pao, Tzu Jan K'o Hsueh

Acta Univ. Upsaliensis, Abstr. Uppsala Diss. Sci.
Acta Universitatis Upsaliensis, Abstracts of Uppsala Dissertations in Science *(Sweden)*

Advan. Contr. Syst.
Advances in Control Systems *(U. S.)*

Advan. Cryog. Eng.
Advances in Cryogenic Engineering *(U. S.)*

Advan. Nucl. Phys.
Advances in Nuclear Physics *(U. S.)*

Advan. Polym. Sci.
Advances in Polymer Science
see Fortschr. Hochpolym.-Forsch.

Advan. X-Ray Anal.
Advances in X-Ray Analysis *(U. S.)*

Agr. Hokkaido
Agriculture in Hokkaido
see Hokuno

Agr. Res. (New Delhi)
Agricultural Research (New Delhi) *(India)*

Air Water Pollut.
*Air and Water Pollution (formerly International Journal of Air Water Pollution) *(U. S.–England)*

Ala. J. Med. Sci.
Alabama Journal of Medical Sciences, The *(U. S.)*

Alloy Dig. Zr-3
Alloy Digest Zr-3 *(U.S.)*

Ann. Acad. Sci. Fenn., Ser. A IV
Annales Academiae Scientiarum Fennicae, Series A IV *(Finland)*

Ann. Bot. Fenn.
Annales Botanici Fennici *(Finland)*

Ann. Dent.
Annals of Dentistry *(U. S.)*

Ann. Ponts Chaussees
Annales des Ponts et Chaussees *(France)*

Annu. ISA (Instrum. Soc. Amer.) Conf. Proc.
Annual ISA (Instrument Society of America) Conference Proceedings *(U. S.)*

Ann. Univ. Mariae Curie-Sklodowska, Lublin-Pol., Sect. DD
*Annales Universitatis Mariae Curie-Sklodowska, Lublin-Polonia, Sectio DD *(Poland)*

Ann. Univ. Sci. Budapest. Rolando Eotvos Nominatae, Sect. Geol.
*Annales Universitatis Scientiarum Budapestinensis de Rolando Eotvos Nominatae, Sectio Geologica *(Hungary)*

Annu. Rep. Res. Inst. Environ. Med., Nagoya Univ.
Annual Report of the Research Institute of Environmental Medicine, Nagoya University *(Japan)*

Annu. Rev. Genet.
Annual Review of Genetics *(U.S.)*

An. Univ. Bucuresti, Ser. Stiint. Natur., Fiz.
Analele Universitatii Bucuresti, Seria Stiintele Naturii, Fizica *(Romania)*

Arbeitsgemeinsch. Forsch. Landes Nordrhein-Westfalen
Arbeitsgemeinschaft fuer Forschung des Landes Nordrhein-Westfalen *(West Germany)*

Arbeitsmed.-Sozialmed.-Arbeitshyg.
Arbeitsmedizin-Sozialmedizin-Arbeitshygiene *(West Germany)*

Arch. Jap. Chir.
Archiv fuer Japanische Chirurgie
see Nippon Geka Hokan

Arch. Mineral.
Archiwum Mineralogiczne *(Poland)*

Arch. Neer. Sci. Exactes Natur.
Archives Neerlandaises des Sciences Exactes et Naturelles *(Netherlands)*

Ark. Zool.
Arkiv for Zoologi, Utgivet av Kungl. Svenska Vetenskapsakademien *(Sweden)*

ASM (Amer. Soc. Metals), Trans. Quart.
*ASM (American Society for Metals), Transactions Quarterly (formerly Transactions of the American Society for Metals) *(U. S.)*

Astrofizika
Astrofizika *(Armenian S.S.R.)*

Astron. Tsirk.
Astronomicheskii Tsirkulyar *(U.S.S.R.)*

Astrophys. Lett.
*Astrophysical Letters *(Scotland)*

Astrophys. Space Sci.
*Astrophysics and Space Science *(Netherlands)*

At. Absorption Newslett.
Atomic Absorption Newsletter *(U. S.)*

At. Energy (China)
Atomic Energy (China)
see Yuan Tzu Neng

At. Energy Law J.
Atomic Energy Law Journal *(U. S.)*

Atmos. Environ.
*Atmospheric Environment *(England)*

Aust. J. Mar. Freshwater Res.
Australian Journal of Marine and Freshwater Research *(Australia)*

Aust. J. Zool.
Australian Journal of Zoology *(Australia)*

Aust. Mach. Prod. Eng.
Australian Machinery and Production Engineering *(Australia)*

Australas. Mfr.
Australasian Manufacturer *(Australia)*

Automat. Electron.
Automatica si Electronica *(Romania)*

Bautechnik
Bautechnik, Die *(West Germany)*

Ber. Deut. Ges. Geol. Wiss., Reihe B
Berichte der Deutschen Gesellschaft fuer Geologische Wissenschaften, Reihe B. Mineralogie und Lagerstaettenforschung *(East Germany)*

Berg- Huettenmaenn. Monatsh. Montan. Hochsch. Leoben
Berg- und Huettenmaennische Monatschefte der Montanistischen Hochschule in Leoben *(West Germany)*

Berlin. Wetterkarte, Suppl.
Berliner Wetterkarte, Supplement *(West Germany)*

Beton Zhelezobeton
Beton i Zhelezobeton *(Georgian S.S.R.)*

Biol. Rundsch.
Biologische Rundschau *(East Germany)*

Blech
Blech *(West Germany)*

BNX Rev.
BNX Review *(England)*

Bodenkultur
Bodenkultur, Die *(Austria)*

Boll. Zool.
Bollettino di Zoologia. Pubblicato dall'Unione Zoologica Italiana *(Italy)*

Bol. Univ. Fed. Parana, Fis. Teor.
*Boletim da Universidade Federal do Parana, Fisica Teorica *(Brazil)*

Brain Res.
Brain Research *(Netherlands)*

Brit. Food J.
British Food Journal *(England)*

Brit. J. Plast. Surg.
British Journal of Plastic Surgery *(Scotland)*

Brit. Mycol. Soc. Trans.
British Mycological Society Transactions, The *(England)*

Brit. Plast.
British Plastics *(England)*

Bull. Astron.
Bulletin Astronomique *(France)*

Bull. Belgicatom
Bulletin Belgicatom (formerly Belgicatom, Association Belge pour le Developpement Pacifique de l'Energie Atomique, Bulletin d'Information) *(Belgium)*

Bull. Calcutta Math. Soc.
Bulletin of the Calcutta Mathematical Society *(India)*

Bull. Eidgenoess. Gesundh., Beil. B
Bulletin des Eidgenoessischen Gesundheitsamtes, Beilage B *(Switzerland)*

Bull. Entomol. Res.
Bulletin of Entomological Research *(England)*

Bull. Fac. Eng., Hiroshima Univ.
Bulletin of the Faculty of Engineering, Hiroshima University
see Hiroshima Daigaku Kogakubu Kenkyu Hokoku

Bull. Fac. Sci. Eng., Chuo Univ.
Bulletin of the Faculty of Science and Engineering, Chuo University
see Chuo Daigaku Rikogakubu Kiyo

Bull. Inst. Geophys., Nat. Cent. Univ.
*Bulletin of the Institute of Geophysics, National Central University *(China (Taiwan))*

Bull. Inst. Int. Froid, Annexe
Bulletin de l'Institut International du Froid, Annexe *(France)*

Bull. Inst. Space Aeronaut. Sci., Univ. Tokyo
Bulletin of the Institute of Space and Aeronautical Science, University of Tokyo
see Tokyo Daigaku Uchu Koku Kenkyusho Hokoku

Bull Int. Inst. Refrig., Suppl.
Bulletin of the International Institute of Refrigeration, Supplement
see Bull. Inst. Int. Froid, Annexe

Bull. Kyoto Educ. Univ., Ser. B
Bulletin of the Kyoto Educational University, Series B. Mathematics and Natural Science *(Japan)*

Bull. Office Int. Epizoot.
Bulletin de l'Office International des Epizooties *(France)*

Bull. Res. Inst. Miner. Dressing Met., Tohoku Univ.
Bulletin of the Research Inst. of Mineral Dressing and Metallurgy, Tohoku University
see Tohoku Daigaku Senko Seirae Kenkyusho Iho

Bull. Soc. Roy. Bot. Belg.
Bulletin de la Societe Royale de Botanique de Belgique *(Belgium)*

Bull. Tulane Univ. Med. Fac.
Bulletin of the Tulane University Medical Faculty *(U.S.)*

Bus. Week
Business Week *(U. S.)*

CA–Cancer J. Clin.
CA– Cancer Journal Clinicians *(U.S.)*

Cah. Ing. Agron.
Cahiers des Ingenieurs Agronomes *(France)*

Cah. Oceanogr.
Cahiers Oceanographiques *(France)*

Calcified Tissue Res.
Calcified Tissue Research *(West Germany)*

Can. J. Psychol.
Canadian Journal of Psychology *(Canada)*

Can. Mach. Metalwork.
Canadian Machinery and Metalworking *(Canada)*

Canner/Packer
Canner/Packer *(U. S.)*

Can. Nurse
Canadian Nurse *(Canada)*

Cercet. Met.
Cercetari Metalurgice *(Romania)*

Chem. Process. (London)
Chemical Processing (London) *(England)*

Chesapeake Sci.
Chesapeake Science *(U. S.)*

Chim. Ind., Genie Chim.
Chimie et Industrie, Genie Chimique (formed by the merger of Chimie et Industrie (Paris) and Genie Chimique (Paris)) *(France)*

Chin. Anim. Husb. Vet. Med.
Chinese Animal Husbandry and Veterinary Medicine
see Chung Kuo Hsu Mu Shou I

Chin. J. Gynecol. Obstet.
Chinese Journal of Gynecology and Obstetrics
see Chung Hua Fu Ch'an K'o Tsa Chih

Chin. J. Surg.
Chinese Journal of Surgery
see Chung Hua Wai K'o Tsa Chih

Chung Hua Fu Ch'an K'o Tsa Chih
Chung Hua Fu Ch'an K'o Tsa Chih (Chinese Journal of Gynecology and Obstetrics) *(China)*

Chung Hua I Hsueh Tsa Chih
Chung Hua I Hsueh Tsa Chih (National Medical Journal of China) *(China)*

Chung Hua Wai K'o Tsa Chih
Chung Hua Wai K'o Tsa Chih (Chinese Journal of Surgery) *(China)*

Chung Kuo Hsu Mu Shou I
Chung Kuo Hsu Mu Shou I (Chinese Animal Husbandry and Veterinary Medicine) *(China)*

Chuo Daigaku Rikogakubu Kiyo
Chuo Daigaku Rikogakubu Kiyo (Bulletin of the Faculty of Science and Engineering, Chuo University) *(Japan)*

Civil Eng. (N. Y.)
Civil Engineering (New York) *(U. S.)*

Coal Age
Coal Age *(U. S.)*

Cobalt
Cobalt *(France)*

Colloid J. (USSR) (Engl. Transl.)
Colloid Journal (USSR) (English Translation of Kolloidnyi Zhurnal) *(U. S.)*

Colloq. Int. Cent. Nat. Rech. Sci.
Colloques Internationaux du Centre National de la Recherche Scientifique *(France)*

Combustion
Combustion *(U.S.)*

Commer. Fish. Rev.
Commercial Fisheries Review *(U. S.)*

Compt. Rend. Soc. Geol. Fr.
Compte Rendu Sommaire des Seances de la Societe Geologique de France *(France)*

Comput. Biomed. Res.
Computers and Biomedical Research *(U. S.)*

Concrete J.
Concrete Journal
see Kenkuito Jaaru

Constr. Mashi
Constructia de Masini *(Romania)*
Coord. Chem. Rev.
Coordination Chemistry Reviews *(Netherlands)*
Cuivre, Laitons, Alliages
Cuivre, Laitons, Alliages *(France)*
Curr. Mod. Biol.
Currents in Modern Biology *(Netherlands)*
Czas. Stomatol.
Czasopismo Stomatologiczne *(Poland)*
Dan. Med. Bull.
Danish Medical Bulletin *(Denmark)*
Denki Shikenjo Kenkyu Hokoku
Denki Shikenjo Kenkyu Hokoku (Researches of the Electrotechnical Laboratory) *(Japan)*
Desalination
Desalination *(Netherlands)*
Deut. Hydrogr. Z.
Deutsche Hydrographische Zeitschrift *(West Germany)*
Deut. Zahn-, Mund- Kieferheilk.
Deutsche Zahn-, Mund- und Kieferheilkunde mit Zentralblatt fuer die Gesamte Zahn-, Mund- und Kieferheilkunde *(East Germany)*
Diffus. Data
*Diffusion Data *(U. S.)*
Doboku Gijutsu
Doboku Gijutsu (Civil Engineering) *(Japan)*
Doc-Air-Espace
*Doc-Air-Espace *(France)*
Dokl.–Bot. Sci. Sect. (Engl. Transl.)
Doklady–Botanical Sciences Sections (English Translation) *(U.S.)*
Earth-Sci. Rev.
Earth-Science Reviews *(Netherlands)*
Eiyo To Shokuryo
Eiyo To Shokuryo (Journal of Japanese Society of Food and Nutrition) *(Japan)*
Electron. Ind. (Paris).
Electronique Industrielle (Paris) *(France)*
Electron. Packag. Prod.
Electronic Packaging and Production *(U. S.)*
Electrotechniek
Electrotechniek *(Netherlands)*
Elec. World
Electrical World *(U. S.)*
Elec. World (Shanghai)
Electrical World (Shanghai)
see Tien Shih Chieh
Elektromedizin
Elektromedizin und ihre Grenzgebiete *(Germany)*
Elektron. Bol'shikh Moshch.
Elektronika Bol'shikh Moshchnostei *(U.S.S.R.)*
Elektron. Obrab. Mater.
Elektronnaya Obrabotka Materialov *(Moldavian S.S.R.)*
Elektrotech. Cas.
Elektrotechnicky Casopis *(Czechoslovakia)*
Elektrotekhnika
Elektrotekhnika *(U.S.S.R.)*
Elektr. Sta.
Elektricheskie Stantsii *(U.S.S.R.)*
Engei Gakkai Zasshi
Engei Gakkai Zasshi (Journal of the Japanese Society for Horticultural Science) *(Japan)*
Engl. Elec. J.
English Electric Journal *(England)*
Entropie
Entropie *(France)*
Ergonomics
Ergonomics *(England)*
Exp. Pathol.
Experimentelle Pathologie *(East Germany)*
Farm, Ranch, Home Quart.
Farm, Ranch and Home Quarterly *(U. S.)*
FDA (Food Drug Admin.) Pap.
FDA (Food and Drug Administration) Papers *(U. S.)*
Fiz. Chastits Vys. Energ., Akad. Nauk Gruz. SSSR, Inst. Fiz.
Fizika Chastits Vysokikh Energii, Akademiya Nauk Gruzinskoi SSR, Institut Fiziki *(Georgian S.S.R.)*
Fiziol. Norm. Patol. (Bucharest)
Fiziologia Normala si Patologica (Bucharest) *(Romania)*
Fiz. Khim. Obrab. Mater.
Fizika i Khimiya Obrabotki Materialov *(U.S.S.R.)*
Fiz. Tekh. Poluprov.
*Fizika i Tekhnika Poluprovodnikov *(U.S.S.R.)*
Flame Notes, Beckman
Flame Notes, Beckman *(U. S.)*
FOA (Forsvarets Forsk.) Rep.
*FOA (Forsvarets Forskningsanstalt) Reports *(Sweden)*
Folia Haematol. (Leipzig)
Folia Haematologia (Leipzig) *(East Germany)*
Folia Med. Cracov.
Folia Medica Cracoviensia *(Poland)*
Forest. Abstr.
Forestry Abstracts *(England)*
Fortschr. Hochpolym.-Forsch.
Fortschritte der Hochpolymeren-Forschung *(West Germany)*
Fortschr. Zool.
Fortschritte de Zoologie *(West Germany)*
Foundry
Foundry *(U. S.)*
Freiberg. Forschungsh., B
Freiberger Forschungshefte, Reihe B *(East Germany)*
Fukuoka Acta Med.
Fukuoka Acta Medica
see Fukuoka Igaku Zasshi
Fukuoka Igaku Zasshi
Fukuoka Igaku Zasshi (Fukuoka Acta Medica) *(Japan)*
Fukushima Daigaku Gakugei Gakubu Rika Hokoku
Fukushima Daigaku Gakugei Gakubu Rika Hokoku (The Science Reports of the Faculty of Arts and Science, Fukushima University) *(Japan)*
Genet. Pol.
*Genetica Polonica *(Poland)*
Geofiz. Byull.
Geofizicheskii Byulleten *(U.S.S.R.)*
Geofys. Sb.
Geofysikalni Sbornik *(Czechoslovakia)*
Geol. Geofiz.
Geologiya i Geofizika *(U.S.S.R.)*
Geol. Nefti Gaza
Geologiya Nefti i Gaza† *(U.S.S.R.)*
Geophys. Geol. (Leipzig)
Geophysik und Geologie (Leipzig) *(East Germany)*
Gidroaeromekhanika
Gidroaeromekhanika *(Ukrainian S.S.R.)*
Haikan Gijutsu
Haikan Gijutsu (The Piping Engineering) *(Japan)*
Handb. Med. Radiol.
Handbuch der Medizinschen Radiologie *(West Germany)*
Harper Hosp. Bull.
Harper Hospital Bulletin *(U. S.)*
Health Lab. Sci.
Health Laboratory Science *(U. S.)*
Heidelberg. Akad. Wiss. Math.-Naturwiss. Kl., Sitzungsber.
Heidelberger Akademie der Wissenschaften. Mathematisch-Naturwissenschaftliche Klasse, Sitzungsberichte *(West Germany)*
Hemel Dampkring
Hemel en Dampkring *(Belgium)*
Hiroshima Daigaku Kogakubu Kenkyu Hokoku
Hiroshima Daigaku Kogakubu Kenkyu Hokoku (Bulletin of the Faculty of Engineering, Hiroshima University) *(Japan)*
Hoken Butsuri
Hoken Butsuri (Journal of Japan Health Physics Society) *(Japan)*
Hokuno
Hokuno (Agriculture in Hokkaido) *(Japan)*
Honvedorvos
Honvedorvos *(Hungary)*
Hyogo Noka Daigaku Kiyo
Hyogo Noka Daigaku Kiyo (Memoirs of the Hyogo University of Agriculture) *(Japan)*
Idengaku Zasshi, Suppl.
Idengaku Zasshi, Supplement (Japanese Journal of Genetics, Supplement) *(Japan)*
IEEE (Inst. Elec. Electron. Eng.) Trans. Audio Electroacoust.
*IEEE (Institute of Electrical and Electronics Engineers) Transactions on Audio and Electroacoustics *(U.S.)*
Ind.-Anz.
Industrie-Anzeiger *(West Germany)*
Ind.-Elektron. Forsch. Fertigung
Industrie-Elektronik in Forschung und Fertigung *(West Germany)*
Indian J. Agr. Sci.
Indian Journal of Agricultural Science, The *(India)*
Indian J. Appl. Chem.
Indian Journal of Applied Chemistry *(India)*
Indian J. Cancer
Indian Journal of Cancer *(India)*
Indian J. Occup. Health
Indian Journal of Occupational Health *(India)*
Indian Pediat.

Indian Pediatrics *(India)*
Ind. Minerario
Industria Mineraria *(Italy)*
Ind. Water Eng.
Industrial Water Engineering *(U. S.)*
Inform. Byull. Sov. Antarkt. Eksped.
Informatsionnyi Byulleten Sovetskoi Antarkticheskoi Ekspeditsii *(U.S.S.R.)*
Ing. Bygningsv., Ugeoversigt
Ingenieur- og Bygningsvaesen, Ugeoversigt *(Denmark)*
Inst. Mining Met., Trans./Sect. B
Institution of Mining and Metallurgy, Transactions/Section B. Applied Earth Science (continues in part Transactions of the Institution of Mining and Metallurgy) *(England)*
Inst. Petrol. Rev.
Institute of Petroleum Review, The *(England)*
Instrum. Contr. Eng.
Instrument and Control Engineering *(England)*
Instrum. Med.
Instrumentation in Medicine *(England)*
Int. Ass. Sci. Hydrol., Bull.
International Association of Scientific Hydrology, Bulletin *(Belgium)*
Int. Chem. Eng.
*International Chemical Engineering. A Quarterly Journal of Translations from Russia, Eastern Europe, and Asia *(U. S.)*
Int. J. Neurol.
International Journal of Neurology *(U. S.)*
Int. Rev. Gesam. Hydrobiol.
Internationale Revue der Gesamten Hydrobiologie *(East Germany)*
Int. Surg.
International Surgery *(U. S.)*
Inzh. Zh., Mekh. Tverd. Tela
Inzhenernyi Zhurnal, Mekhanika Tverdogo Tela (formerly Inzhenernyi Zhurnal) *(U.S.S.R.)*
Iron Age Metalwork. Int.
Iron Age Metalworking International *(U. S.)*
ISA (Instrum. Soc. Amer.), Proc., Nat. Power Instrum. Symp.
ISA (Instrument Society of America), Proceedings, National Power Instrumentation Symposium *(U. S.)*
Izobret., Prom. Obraztsy, Tovarnye Znaki
Izobreteniya, Promyshlennye Obraztsy, Tovarnye Znaki *(U.S.S.R.)*
Izv. Akad. Nauk Arm. SSR, Ser. Tekh. Nauk
Izvestiya Akademii Nauk Armyanskoi SSR, Seriya Tekhnicheskikh Nauk *(Armenian S.S.R.)*
Izv. Akad. Nauk SSSR, Ser. Biol.
Izvestiya Akademii Nauk SSSR, Seriya Biologicheskaya *(U.S.S.R.)*
Izv. Akad. Nauk SSSR, Ser. Geol.
Izvestiya Akademii Nauk SSSR, Seriya Geologicheskaya *(U.S.S.R.)*
Izv. Akad. Nauk SSSR, Ser. Mat.
Izvestiya Akademii Nauk SSSR, Seriya Matematicheskaya *(U.S.S.R.)*
Izv. Akad. Nauk Tadzh. SSR, Otd. Fiz.-Tekh. Khim. Nauk
Izvestiya Akademii Nauk Tadzhikskoi SSR, Otdelenie Fiziko-Tekhnicheskikh i Khimicheskikh Nauk *(Tadzhik S.S.R.)*
Izv. Inst. Khidrol. Meteorol., Bulg. Akad. Nauk.
Izvestiya na Institutapo Khidrologiya i Meteorologiya, Bulgarska Akademiya na Naukite, Otdelenie za Matematicheski i Fizicheski Nauki *(Bulgaria)*
Izv. Vyssh. Uchob. Zaved., Priborostr.
Izvestiya Vysshikh Uchebnykh Zavedenii, Priborostroenie *(U.S.S.R.)*
Izv. Vyssh. Uchob. Zaved., Tekhnol. Legk. Prom.
Izvestiya Vysshikh Uchebnykh Zavedenii, Tekhnologiya Legkoi Promyshlennosti *(Ukrainian S.S.R.)*
J. Amer. Podiat. Ass.
Journal of the American Podiatry Association *(U. S.)*
Jap. J. Dairy Sci.
Japanese Journal of Dairy Science (Japan)
see ***Rakuno Kagaku no Kenkyu***
Jap. J. Exp. Morphol.
Japanese Journal of Experimental Morphology
see ***Jikken Keitaigakushi***
Jap. J. Genet., Suppl.
Japanese Journal of Genetics, Supplement
see ***Idengaku Zasshi, Suppl.***
Jap. J. Pharm. Chem.
Japanese Journal of Pharmacy and Chemistry
see ***Yakugaku Kenkyu***
Jap. J. Zootech. Sci.
Japanese Journal of Zootechnical Science
see ***Nippon Chikusangaku Kaiho***

JARE Sci. Rep., Spec. Issue
JARE Scientific Reports, Special Issue *(Japan)*
J. Aust. Ceram. Soc.
Journal of the Australian Ceramic Society *(Australia)*
J. Balneol. Soc. Jap.
Journal of the Balneological Society of Japan
see ***Onsen Kagaku***
J. Belge Radiol., Monogr.
*Journal Belge de Radiologie, Monographie *(Belgium)*
J. Cell Sci.
*Journal of Cell Science *(England)*
J. Egypt. Public Health Ass.
Journal of the Egyptian Public Health Association *(Egypt)*
Jeune Sci.
Jeune Scientifique *(Canada)*
J. Forensic Med.
Journal of Forensic Medicine *(South Africa)*
J. Formosan Med. Ass.
Journal of the Formosan Medical Association
see ***T'ai-wan I Hsueh Hui Tsa Chih***
J. Geol.
Journal of Geology *(U. S.)*
Jibiinkoka Rinsho
Jibiinkoka Rinsho (Oto-Rhino-Laryngological Clinic) *(Japan)*
Jikken Keitaigakushi
Jikken Keitaigakushi (Japanese Journal of Experimental Morphology) *(Japan)*
J. Indian Soc. Soil Sci.
Journal of the Indian Society of Soil Science *(India)*
J. Inst. Safety High Pressure Gas Eng.
Journal of the Inst. of Safety of High Pressure Gas Engineering
see ***Koatsu Gasu***
J. Inst. Telecommun. Eng.
Journal of the Institution of Telecommunication Engineers *(India)*
J. Irrig. Drain. Div., Amer. Soc. Civil Eng.
Journal of the Irrigation and Drainage Division, Proceedings of the American Society of Civil Engineers *(U. S.)*
J. Jap. Health Phys. Soc.
Journal of Japan Health Physics Society
see ***Hoken Butsuri***
J. Jap. Soc. Food Nutr.
Journal of Japanese Society of Food and Nutrition
see ***Eiyo To Shokuryo***
J. Jap. Soc. Hort. Sci.
Journal of the Japanese Society for Horticultural Science
see ***Engei Gakkai Zasshi***
J. Jap. Stomatol. Soc.
Journal of the Japan Stomatological Society, The
see ***Kokubyo Gakkai Zasshi***
J. Jap. Tech. Ass. Pulp Pap. Ind.
Journal of the Japanese Technical Association of Pulp and Paper Industry
see ***Kami Pa Gikyoshi***
J. Jap. Wood Res. Soc.
Journal of the Japan Wood Research Society
see ***Mokuzai Gakkaishi***
J. Karnatak Univ.
Journal of the Karnatak University *(India)*
J. Macromol. Sci., Part A
Journal of Macromolecular Science, Part A. Chemistry (supersedes Journal of Macromolecular Chemistry) *(U. S.)*
J. Marine Res.
Journal of Marine Research (Sears Foundation for Marine Research) *(U.S.)*
J. Metal Finish. Soc. Jap.
Journal of the Metal Finishing Society of Japan, The
see ***Kinzoku Hyomen Gijutsu***
J. Nagasaki Med. Ass., Suppl.
Journal of the Nagasaki Medical Association, Supplement
see ***Nagasaki Igakkai Zasshi, Suppl.***
J. Nucl. Med., Suppl.
*Journal of Nuclear Medicine, Supplement *(U.S.)*
J. Nucl. Sci. (Seoul)
*Journal of Nuclear Sciences (Seoul) (Wonjaryogwon. Yon'gu Nonmun Chip) *(South Korea)*
J. Paleontol.
Journal of Paleontology *(U.S.)*
J. Phys., A (London)
*Journal of Physics, A (London), Proceedings of the Physical Society (General) (supersedes in part Proceedings of the Physical Society (London)) *(England)*
J. Phys., B (London)
*Journal of Physics, B (London), Proceedings of the Physical Society (Atomic and Molecular Physics) (supersedes in part Proceedings of the Physical Society (London)) *(England)*

J. Phys., C (London)
*Journal of Physics, C (London), Proceedings of the Physical Society (Solid State Physics) (supersedes in part Proceedings of the Physical Society (London)) *(England)*

J. Phys., E (London)
*Journal of Physics, E (London) (supersedes Journal of Scientific Instruments) *(England)*

J. Phys. Chem. Solids, Suppl.
*Journal of Physics and Chemistry of Solids, Supplement *(England)*

J. Radiol. Phys. Ther., Univ. Kanazawa
Journal of Radiology and Physical Therapy, University of Kanazawa, The
see **Kanazawa Irigaku Sosho**

J. Roy. Army Med. Corps
Journal of the Royal Army Medical Corps *(England)*

J. Soc. Eng. Miner. Springs, Jap.
Journal of the Society of Engineers for Mineral Springs, Japan
see **Onsen Kogakkaishi**

J. Soc. Fiber Sci. Technol., Jap.
Journal of the Society of Fiber Science and Technology, Japan
see **Sen'i Gakkaishi**

J. Soc. Instrum. Contr. Eng.
Journal of the Society of Instrument and Control Engineers
see **Keisoku To Seigyo**

J. Soc. Leather Trades Chem.
Journal of the Society of Leather Trades Chemists *(England)*

J. Soc. Rubber Ind., Jap.
Journal of the Society of Rubber Industry, Japan
see **Nippon Gomu Kyokaishi**

Jugoslov. Pronalazastvo
Jugoslovensko Pronalazastvo *(Yugoslavia)*

Kagaku Keisatsu Kenkyusho Hokoku
Kagaku Keisatsu Kenkyusho Hokoku (Reports of the National Research Inst. of Police Science) *(Japan)*

Kagoshima Daigaku Suisangakubu Kiyo
Kagoshima Daigaku Suisangakubu Kiyo (Memoirs of the Faculty of Fisheries, Kagoshima University) *(Japan)*

Kaibogaku Zasshi
Kaibogaku Zasshi (Acta Anatomica Nipponica) *(Japan)*

Kali Steinsalz
Kali und Steinsalz *(West Germany)*

Kami Pa Gikyoshi
Kami Pa Gikyoshi (Journal of the Japanese Technical Association of Pulp and Paper Industry) *(Japan)*

Kanazawa Irigaku Sosho
Kanazawa Irigaku Sosho (Journal of Radiology and Physical Therapy, University of Kanazawa, The) *(Japan)*

Keisoku To Seigyo
Keisoku To Seigyo (Journal of the Society of Instrument and Control Engineers) *(Japan)*

Kinzoku Hyomen Gijutsu
Kinzoku Hyomen Gijutsu (The Journal of the Metal Finishing Society of Japan) *(Japan)*

Klin. Monatsbl. Augenheilk.
Klinische Monatsblaetter fuer Augenheilkunde und fuer Augenaerztliche Fortbildung *(West Germany)*

Koatsu Gasu
Koatsu Gasu (Journal of the Inst. of Safety of High Pressure Gas Engineering) *(Japan)*

Kobe Kogyo Giho
Kobe Kogyo Giho (Kobe Kogyo Technical Report) *(Japan)*

Kobe Kogyo Tech. Rep.
Kobe Kogyo Technical Report
see **Kobe Kogyo Giho**

K'o Hsueh Tu Chung
K'o Hsueh Tu Chung (Popular Science) *(China)*

Kokubyo Gakkai Zasshi
Kokubyo Gakkai Zasshi (Journal of the Japan Stomatological Society, The) *(Japan)*

Konkurito Jaanaru
Konkurito Jaanaru (Concrete Journal) *(Japan)*

Konserv. Ovoshchesush. Prom.
Konservnaya i Ovoshchesushil'naya Promyshlennost *(U.S.S.R.)*

Korroz. Metal. Splavov
Korroziya Metallov i Splavo *(U.S.S.R.)*

Kosm. Biol. Med.
Kosmicheskaya Biologiya i Meditsina *(U.S.S.R.)*

Kosm. Luchi
Kosmicheskie Luchi *(U.S.S.R.)*

Kovove Mater.
Kovove Materialy *(Czechoslovakia)*

Kowan Gikan Shiryo
Kowan Gikan Shiryo (Technical Note of Port and Harbour Technical Research Inst., Ministry of Transportation, Japan) *(Japan)*

Krist. Tech.
Kristall und Technik *(East Germany)*

Kumamoto Daigaku Kogakubu Kenkyu Hokoku
Kumamoto Daigaku Kogakubu Kenkyu Hokoku (Technical Reports of the Kumamoto University) *(Japan)*

Kumamoto Daigaku Kyoikugakubu Kiyo
Kumamoto Daigaku Kyoikugakubu Kiyo (Memoirs of the Faculty of Education, Kumamoto University) *(Japan)*

Kurznachr. Akad. Wiss. Goettingen
Kurznachrichten der Akademie der Wissenschaften in Goettingen *(West Germany)*

Kyoto Daigaku Kogyo Kyoin Yoseijo Kenkyu Hokoku
Kyoto Daigaku Kogyo Kyoin Yoseijo Kenkyu Hokoku (Report of the Training Inst. for Engineering Teachers, Kyoto University) *(Japan)*

Kyushu Daigaku Kogaku Shuho
Kyushu Daigaku Kogaku Shuho (Technology Reports of the Kyushu University) *(Japan)*

Kyushu Daigaku Seisan Kagaku Kenkyusho Hokoku
Kyushu Daigaku Seisan Kagaku Kenkyusho Hokoku (The Reports of the Research Inst. of Science and Industry, Kyushu University) *(Japan)*

Lakokrasoch. Mater. Ikh Primen.
Lakokrasochnye Materialy i Ikh Primenenie *(U.S.S.R.)*

Landbouwtijdschrift
Landbouwtijdschrift *(Belgium)*

Lasers Opt. Non Conv.
Lasers et Optique Non Conventionelle *(France)*

Lebensversicherungsmedizin
Lebensversicherungsmedizin *(West Germany)*

Light Metals
Light Metals (superseded by Light Metals and Metals Industry (London)) *(England)*

Light Metals Metal Ind. (London)
*Light Metals and Metal Industry (London) (formed by merger of Light Metals and The Metal Industry (London)) *(England)*

Lipids
Lipids *(U. S.)*

Liteinoe Proizvod.
Liteinoe Proizvodstvo *(U.S.S.R.)*

Lutte Cancer
Lutte Contre le Cancer *(France)*

Machinery (N. Y.)
Machinery (New York) *(U. S.)*

Mach. Prod. Eng.
Machinery and Production Engineering *(England)*

Mach. Shop Eng. Mfg.
Machine Shop and Engineering Manufacture *(England)*

Mach. Tool Blue Book
Machine and Tool Blue Book *(U. S.)*

Mag. Stand.
Magazine of Standards *(U. S.)*

Magy. Traumatol., Orthop. Helyreallito Sebesz.
Magyar Traumatologia, Orthopaedia es Helyreallito Sebeszet *(Hungary)*

Manage. Sci.
Management Science *(U.S.)*

Mashinovedenie
Mashinovedenie *(U.S.S.R.)*

Mass Prod.
Mass Production *(England)*

Mater. Res. Bull.
Materials Research Bulletin *(U. S.)*

Mech. World Eng. Rec.
*Mechanical World and Engineering Record *(England)*

Med. Bull. U. S. Army, Eur.
Medical Bulletin of the U. S. Army, Europe *(U.S.)*

Med. Radiol. (USSR) (Engl. Transl.)
Medical Radiology (USSR) (English Translation of Meditsinskaya Radiologiya) *(U. S.)*

Mem. Fac. Educ., Kumamoto Univ.
Memoirs of the Faculty of Education, Kumamoto University
see **Kumamoto Daigaku Kyoikugakubu Kiyo**

Mem. Fac. Fish., Kagoshima Univ.
Memoirs of the Faculty of Fisheries, Kagoshima University
see **Kagoshima Daigaku Suisangakubu Kiyo**

Mem. Fac. Sci., Kyoto Univ., Ser. Biol.
Memoirs of the Faculty of Science, Kyoto University, Series of Biology (formerly Memoirs of the College of Science, University of Kyoto, Series B (Biology)) *(Japan)*

Mem. Fac. Sci., Kyoto Univ., Ser. Phys., Astrophys., Geophys., Chem.
Memoirs of the Faculty of Science, Kyoto University, Series of Physics, Astrophysics, Geophysics, and Chemistry (formerly Memoirs of the College of Science, University of

Kyoto, Series A) *(Japan)*

Mem. Hyogo Univ. Agr.
Memoirs of the Hyogo University of Agriculture
see Hyogo Noka Daigaku Kiyo

Meres Automat.
Meres es Automatika *(Hungary)*

Mes., Regul., Automat.
Mesures, Regulation, Automatisme *(France)*

Metabolism
*Metabolism: Clinical and Experimental *(U. S.)*

Metallwirtschaft
Metallwirtschaft–Wissenschaft–Technik *(Germany)*

Metals (London)
Metals (London) *(England)*

Metals Abstr.
*Metals Abstracts (successor to Review of Metal Literature and Metallurgical Abstracts) *(U. S.-England)*

Metal Sci. Heat Treat. (USSR) (Engl. Transl.)
Metal Science and Heat Treatment (USSR) (English Translation of Metallovedenie i Termicheskaya Obrabotka Metallov) *(U. S.)*

Metal Treat.
Metal Treating *(U. S.)*

Met. Elec. (Madrid)
Metalurgia y Electricidad (Madrid) *(Spain)*

Met. Rev. (Publ. in Metals Mater.)
Metallurgical Reviews (Published in Metals and Materials) *(England)*

Microwaves
Microwaves *(U. S.)*

Miner. Deposita
Mineralium Deposita *(West Germany)*

Mining Met. Quart. (USSR) (Engl. Transl.), Suppl.
Mining and Metallurgy Quarterly, (USSR) (English Translation of Rudarsko-Metalurski Zbornik, Supplement) *(Yugoslavia)*

Mod. Packag.
Modern Packaging *(U. S.)*

Mokuzai Gakkaishi
Mokuzai Gakkaishi (Journal of the Japan Wood Research Society) *(Japan)*

Mol. Biol.
*Molekulyarnaya Biologiya *(U.S.S.R.)*

Mon. Corresp. Befoerd. Erd Himmelskunde
Monatliche Correspondenz zur Befoerderung der Erd und Himmelskunde *(East Germany)*

Monit. Zool. Ital., Suppl.
Monitore Zoologico Italiano, Supplemento *(Italy)*

Montes
Montes *(Spain)*

Motor Ship
Motor Ship *(England)*

Motortech. Z.
Motortechnische Zeitschrift *(West Germany)*

Nachrichtentechnik
Nachrichtentechnik *(East Germany)*

Nagano Kogyo Koto Senmon Gakko Kiyo
Nagano Kogyo Koto Senmon Gakko Kiyo (Research Reports, Nagano Technical College) *(Japan)*

Nagasaki Igakkai Zasshi, Suppl.
Nagasaki Igakkai Zasshi, Supplement (Journal of the Nagasaki Medical Association, Supplement) *(Japan)*

Nan Ching Ta Hsueh Hsueh Pao, Tzu Jan K'o Hsueh
Nan Ching Ta Hsueh Hsueh Pao, Tzu Jan K'o Hsueh (Acta Universitatis Nankinensis Scientiarum Naturalium) *(China)*

Nat. Fire Codes
National Fire Codes *(U. S.)*

Nat. Med. J. China
National Medical Journal of China
see Chung Hua I Hsueh Tsa Chih

Nauch. Zap. Inst. Mashinoved. Avtomat., Akad. Nauk Ukr. SSR, Ser. Mashinoved.
Nauchnye Zapiski Instituta Mashinovedeniya i Avtomatiki, Akademiya Nauk Ukrainskoi SSR, Seriya Mashinovedeniya *(Ukrainian S.S.R.)*

Nerv. Sist., Leningrad. Gos. Univ., Fiziol. Inst.
Nervnaya Sistema, Leningradskii Gosudarstvennyi Universitet imeni A. A. Zhdanova, Fiziologicheskii Institut *(U.S.S.R.)*

Neth. J. Sea Res.
Netherlands Journal of Sea Research *(Netherlands)*

Neues Jahrb. Mineral., Monatsh.
Neues Jahrbuch fuer Mineralogie, Monatshefte *(West Germany)*

Nippon Byori Gakkai Kaishi
Nippon Byori Gakkai Kaishi (Transactiones Societatis Pathologicae Japonicae) *(Japan)*

Nippon Chikusangaku Kaiho
Nippon Chikusangaku Kaiho (Japanese Journal of Zootechnical Science) *(Japan)*

Nippon Geka Hokan
Nippon Geka Hokan (Archiv fuer Japanische Chirurgie) *(Japan)*

Nippon Gomu Kyokaishi
Nippon Gomu Kyokaishi (Journal of the Society of Rubber Industry, Japan) *(Japan)*

Nippon Sakumotsu Gakkai Kiji
Nippon Sakumotsu Gakkai Kiji (Proceedings of the Crop Science Society of Japan) *(Japan)*

Nisshin Seiko Giho
Nisshin Seiko Giho (Technical Report of Nisshin Steel Co., Ltd.) *(Japan)*

Norsk Skogind.
Norsk Skogindustri *(Norway)*

Nukleonika, Supl.
*Nukleonika, Suplement *(Poland)*

N. Z. Sci. Rev.
New Zealand Science Review *(New Zealand)*

Oceanogr. Mag.
Oceanographical Magazine, The *(Japan)*

Ochr. Pr.
Ochrona Pracy *(Poland)*

Odontol. Tidskr.
Odontologisk Tidskrift *(Sweden)*

Oftal'mol. Zh.
Oftal'mologicheskii Zhurnal *(Ukrainian S.S.R.)*

Okayama Daigaku Onsen Kenkyusho Hokoku
Okayama Daigaku Onsen Kenkyusho Hokoku (Papers of the Inst. for Thermal Spring Research, Okayama University) *(Japan)*

Onde Elec., Suppl.
*Onde Electrique, L, Supplement *(France)*

Onsen Kagaku
Onsen Kagaku (Journal of the Balneological Society of Japan) *(Japan)*

Onsen Kagakkaishi
Onsen Kagakkaishi (Journal of the Society of Engineers for Mineral Springs, Japan) *(Japan)*

Opt.-Mekh. Prom.
Optiko-Mekhanicheskaya Promyshlennost *(U.S.S.R.)*

Osaka Furitsu Kogyo Shoreikan Hokoku
Osaka Furitsu Kogyo Shoreikan Hokoku (Reports of Industrial Research Inst., Osaka Prefecture) *(Japan)*

Oto-Rhino-Laryngol. Clin.
Oto-Rhino-Laryngological Clinic
see Jibiinkoka Rinsho

Paperi Puu-Lehdesta
Paperi ja Puu-Lehdesta *(Finland)*

Pap. Inst. Thermal Spring Res., Okayama Univ.
Papers of the Inst. for Thermal Spring Research, Okayama University
see Okayama Daigaku Onsen Kenkyusho Hokoku

Pei Ching Ta Hsueh Hsueh Pao, Tzu Jan K'o Hsueh
Pei Ching Ta Hsueh Hsueh Pao, Tzu Jan K'o Hsueh (Acta Scientiarum Naturalium Universitatis Pekinensis) *(China)*

Photogr. Appl. Sci. Technol.
*Photographic Applications in Science and Technology *(U. S.)*

Phys.-Diat. Ther.
Physikalisch-Diaetetische Therapie *(West Germany)*

Phys. Earth Planet. Interiors
*Physics of the Earth and Planetary Interiors *(Netherlands)*

Piping Eng.
Piping Engineering, The
see Haiken Gijutsu

Plant Breed. Abstr.
*Plant Breeding Abstracts *(England)*

Plant Cell Physiol. (Kyoto)
Plant and Cell Physiology (Kyoto) *(Japan)*

Plastics (London)
*Plastics (London) *(England)*

Poluprov. Prib. Ikh Primen., Sb. Statei
Poluprovodnikovye Pribory i Ikh Primenenie, Sbornik Statei *(U.S.S.R.)*

Pop. Sci. (Peking)
Popular Science (Peking)
see K'o Hsueh Tu Chung

Poznan. Tow. Przyj. Nauk, Wydz. Lek., Pr. Kom. Farm.
Poznanskie Towarzystwo Przyjaciol Nauk, Wydzial Lekarski, Prace Komisji Farmaceutycznej *(Poland)*

Praxis (Bern)
Praxis (Bern) *(Switzerland)*

Probl. Fiziol. Opt.
Problemy Fiziologicheskoi Optiki *(U.S.S.R.)*

Proc. Amer. Soc. Hort. Sci.
Proceedings of the American Society for Horticultural Science *(U. S.)*

Proc. Astron. Soc. Aust.
Proceedings of the Astronomical Society of Australia *(Australia)*

Proc. Crop Sci. Soc. Jap.
Proceedings of the Crop Science Society of Japan
see Nippon Sakumotsu Gakkai Kiji

Proc. Indian Acad. Sci., Sect. B
Proceedings of the Indian Academy of Sciences, Section B *(India)*

Proc. La. Acad. Sci.
*Proceedings of the Louisiana Academy of Sciences, The *(U. S.)*

Proc. Nat. Acad. Sci., India, Sect. A
Proceedings of the National Academy of Sciences, India, Section A *(India)*

Proc. Phys. Soc. (London)
Proceedings of the Physical Society (London) changed to Journal of Physics, A, B, and C *(England)*

Proc. Soc. Water Treat. Exam.
Proceedings of the Society for Water Treatment and Examination *(England)*

Proc. (Tr.) P. N. Lebedev Phys. Inst. (USSR) (Engl. Transl.)
*Proceedings (Trudy) of the P. N. Lebedev Physics Institute (USSR) (English Translation of Trudy Fizicheskogo Instituta imeni P. N. Lebedeva, Akademiya Nauk SSSR) *(U. S.)*

Progr. Ind. Microbiol.
Progress in Industrial Microbiology *(U. S.—England)*

Progr. Solid State Chem.
Progress in Solid State Chemistry *(England)*

Prot. Civ. Secur. Ind.
Protection Civile et Securite Industrielle *(France)*

Protein, Nucl. Acid, Enzyme
Protein, Nucleic Acid, Enzyme
see Tanpakushitsu Kakusan Koso

Pubb. Centro Sper. Agr. Forest.
Pubblicazioni del Centro di Sperimentazione Agricola e Forestale *(Italy)*

Queensland Govt. Mining J.
Queensland Government Mining Journal *(Australia)*

Radio (China)
Radio (China)
see Wu Hsien Tien

Radiobiol. Biol. Mol.
Radiobiologia si Biologia Moleculara *(Romania)*

Radioprotection
Radioprotection. Bulletin de la Societe Francaise de Radioprotection *(France)*

Rad. Poljopr. Fak. Univ. Sarajevu
Radovi Poljoprivrednog Fakulteta Univerziteta u Sarajevu *(Yugoslavia)*

Rakuno Kagaku No Kenkyu
Rakuno Kagaku No Kenkyu (Japanese Journal of Dairy Science) *(Japan)*

RCN (Reactor Cent. Ned.) Mededel.
RCN (Reactor Centrum Nederland) Mededeling *(Netherlands)*

Reactor Fuel-Process. Technol.
*Reactor and Fuel-Processing Technology (A Quarterly Technical Progress Review) (formerly Power Reactor Technology and Reactor Fuel Processing) *(U. S.)*

Rec. Trav. Bot. Neer.
Recueil des Travaux Botaniques Neerlandais *(Netherlands)*

Rep. Fac. Sci., Shizuoka Univ.
Reports of Faculty of Science, Shizuoka University *(Japan)*

Rep. Fire Res. Inst. Jap.
Report of Fire Research Inst. of Japan
see Shobo Kenkyusho Hokoku

Rep. Ind. Res. Inst., Osaka Prefect.
Reports of Industrial Research Inst., Osaka Prefecture
see Osaka Furitsu Kogyo Shoreikan Hokoku

Rep. Nat. Res. Inst. Police Sci.
Reports of the National Research Inst. of Police Science
see Kagaku Keisatsu Kenkyusho Hokoku

Rep. Res. Inst. Ind. Safety
Reports of the Research Inst. of Industrial Safety
see Sangyo Anzen Kenkyusho Hokoku

Rep. Res. Inst. Sci. Ind., Kyushu Univ.
Reports of the Research Inst. of Science and Industry, Kyushu University
see Kyushu Daigaku Seisan Kagaku Kenkyusho Hokoku

Rep. Tokyo-to Lab. Med. Sci.
Report of Tokyo-to Lab. for Medical Sciences
see Tokyo Toritsu Eisei Kenkyusho Kenkyu Hokoku

Rep. Train. Inst. Eng. Teach., Kyoto Univ.
Report of the Training Inst. for Engineering Teachers, Kyoto University
see Kyoto Daigaku Kogyo Kyoin Yoseijo Kenkyu Hokoku

Res. Electrotech. Lab.
Researches of the Electrotechnical Laboratory
see Denki Shikenjo Kenkyu Hokoku

Res. Rep., Nagano Tech. Coll.
Research Reports, Nagano Technical College
see Nagano Kogyo Koto Senmon Gakko Kiyo

Rev. Acad. Cienc. Exactas, Fis.-Quim. Natur. Zaragoza
Revista de la Academia de Ciencias Exactas, Fisico-Quimicas y Naturales de Zaragoza *(Spain)*

Rev. Brasil. Quim. (Sao Paulo)
*Revista Brasileria de Quimica *(Brazil)*

Rev. Elec.
Revista Electricidade *(Portugal)*

Rev. Fr. Elec.
*Revue Francaise de l' Electricite *(France)*

Rev. Interamer. Radiol.
Revista Interamericana de Radiologia *(Peru)*

Rev. Laryngol., Otol., Rhinol., Suppl.
Revue de Laryngologie, Otologie, Rhinologie, Supplement *(France)*

Rev. Roum. Sci. Tech., Ser. Mecan. Appl.
Revue Roumaine des Sciences Techniques, Serie de Mecanique Appliquee *(Romania)*

Rev. Zootch. Med. Vet.
Revista de Zootehnic si Medicina Veterinara *(Romania)*

Rheol. Acta
Rheologica Acta *(West Germany)*

Roy. Observ. Bull.
Royal Observatory Bulletins *(England)*

Roy. Soc. Health J.
Royal Society of Health Journal *(England)*

Rudarsko-Met. Zbornik, Suppl.
Rudarsko-Metalurski Zbornik, Supplement *(Yugoslavia)*
For English Translation see Mining Met. Quart., Suppl.

Ruimtevaart
Ruimtevaart *(Netherlands)*

RUM, Rev. Universelle Mines
RUM, Revue Universelle des Mines, de la Metallurgie, de la Mecanique, des Travaux Publics, des Sciences et des Arts Appliques a l' Industrie (formerly Revue Universelle des Mines, de la Metallurgie, de la Mecanique, des Travaux Publics, des Sciences et des Arts Appliques a l'Industrie) *(Belgium)*

S. Afr. Mech. Eng.
South African Mechanical Engineer, The *(South Africa)*

Salt Res. Ind. (Bhavnagar, India)
Salt Research and Industry (Bhavnagar, India) *(India)*

Samoletostr. Tekh. Vozdush. Flota
Samoletostroenie i Tekhnika Vozdushnogo Flota *(U.S.S.R.)*

Sangyo Anzen Kenkyusho Hokoku
Sangyo Anzen Kenkyusho Hokoku (Reports of the Research Inst. of Industrial Safety) *(Japan)*

Sb. Geol. Ved, Uzita Geofyz.
Sbornik Geologickych Ved, Uzita Geofyzika *(Czechoslovakia)*

Sb. Ved. Pr. Lek. Fak. Karlovy Univ. Hradci Kralove, Suppl.
Sbornik Vedeckych Praci Lekarske Fakulty Karlovy University v Hradci Kralove, Supplementum *(Czechoslovakia)*

Scand. J. Clin. Lab. Invest., Suppl.
Scandinavian Journal of Clinical and Laboratory Investigation, Supplement *(Sweden)*

Schweiz. Arch. Tierheilk.
Schweizer Archiv fuer Tierheilkunde *(Switzerland)*

Sciences (Paris)
Sciences et l'Enseignement des Sciences (Paris) *(France)*

Sci. Ind. Spatiales
Sciences et Industries Spatiales *(Switzerland)*

Sci. News (Wash., D. C.)
Science News (Washington, D. C.) *(U. S.)*

Sci. Proc. Roy. Dublin Soc., Ser. A
Scientific Proceedings of the Royal Dublin Society, The, Series A (supersedes The Scientific Proceedings of the Royal Dublin Society, New Series) *(Ireland)*

Sci. Rep., Coll. Gen. Educ., Osaka Univ.
Science Report, College of General Education, Osaka University *(Japan)*

Sci. Rep. Niigata Univ., Ser. B
Science Reports of Niigata University, Series B. Physics *(Japan)*

Scr. Met.
Scripta Metallurgica *(U. S.)*

Seminars Hematol.
*Seminars in Hematology *(U. S.)*

Seminars Roentgenol.
Seminars in Roentgenology *(U. S.)*

Sen'i Gakkaishi
Sen'i Gakkaishi (Journal of the Society of Fiber Science and

Technology, Japan) *(Japan)*

Ser. Haematol.
Series Haematologica (Supplements Scandinavia Journal of Haematology) *(Denmark)*

Sheet Metal Ind.
Sheet Metal Industries *(England)*

Shipping World Shipbuilder
Shipping World and Shipbuilder *(England)*

Shobo Kenkyusho Hokoku
Shobo Kenkyusho Hokoku (Report of Fire Research Inst. of Japan) *(Japan)*

Showa Densen Denran Rebyu
Showa Densen Denran Rebyu (Showa Wire and Cable Review) *(Japan)*

Showa Wire Cable Rev.
Showa Wire and Cable Review
see Showa Densen Denran Rebyu

Sichere Arb.
Sichere Arbeit *(Austria)*

Slaboproudy Obz.
Slaboproudy Obzor *(Czechoslovakia)*

Soc. Petrol. Eng. J.
Society of Petroleum Engineers Journal, The *(U. S.)*

Soil Crop Sci. Soc. Fla., Proc.
Soil and Crop Science Society of Florida, Proceedings *(U. S.)*

Soobshch. Shemakhinskoi Astrofiz. Observ., Akad. Nauk Azerb. SSR
*Soobshcheniya Shemakhinskoi Astrofizicheskoi Observatorii, Akademiya Nauk Azerbaidzhanskoi SSR *(Azerbaidzhan S.S.R.)*

Sov. Antarct. Exped. Inform. Bull.
Soviet Antarctic Expedition Information Bulletin (English Translation of Informatsionnyi Byulleten Sovetskoi Antarkticheskoi Ekspeditsii) *(U. S.)*

Sov. Phys.-Semicond. (Engl. Transl.)
Soviet Physics-Semiconductors (English Translation of Fizika i Tekhnika Poluprovodnikov) *(U. S.)*

Space Biol. Med. (USSR) (Engl. Transl.)
Space Biology and Medicine (USSR) (English Translation of Kosmicheskaya Biologiya i Meditsina) *(U.S.)*

SRW (Siemens-Reiniger-Werke) Nachr.
SRW (Siemens-Reiniger-Werke) Nachricht *(West Germany)*

Stain Technol.
Stain Technology *(U. S.)*

Steel Times
Steel Times *(England)*

Strahlenschutz Forsch. Prax.
Strahlenschutz in Forschung und Praxis *(West Germany)*

Strain
Strain *(England)*

Stud. Cercet. Endocrinol.
Studii si Cercetari de Endocrinologie *(Romania)*

Stud. Cercet. Energ. Electroteh.
Studii si Cercetari de Energetica si Electrotehnica *(Romania)*

Svetsaren Engl.
Svetsaren in English *(Sweden)*

Sv. Lakartidn.
Svenska Lakartidningen *(Sweden)*

T'ai-wan I Hsueh Hui Tsa Chih
T'ai-wan I Hsueh Hui Tsa Chih (Journal of the Formosan Medical Association) *(China (Taiwan))*

Tanpakushitsu Kakusan Koso
Tanpakushitsu Kakusan Koso (Protein, Nucleic Acid, Enzyme) *(Japan)*

Tech. Dig. (Prague)
Technical Digest (Prague), Statni Nakladatelstvi Technicke Literatury *(Czechoslovakia)*

Technik (Berlin)
Technik (Berlin), Die *(East Germany)*

Technol. Rep. Kyushu Univ.
Technology Reports of the Kyushu University
see Kyushu Daigaku Kogaku Shuho

Tech. Note Port Harbour Tech. Res. Inst., Min. Transp., Jap.
Technical Note of Port and Harbour Technical Research Inst., Ministry of Transporation, Japan
see Kowan Giken Shiryo

Tech. Rep. ISSP (Inst. Solid State Phys.), Ser. A
Technical Report of ISSP (Inst. for Solid State Physics), Series A *(Japan)*

Tech. Rep. Kumamoto Univ.
Technical Reports of the Kumamoto University
see Kumamoto Daigaku Kogakubu Kenkyu Hokoku

Tech. Rep. Nisshin Steel Co., Ltd.
Technical Report of Nisshin Steel Co., Ltd.
see Nisshin Seiko Giho

Tekhnol. Organ. Proizvod.
Tekhnologiya i Organizatsiya Proizvodstva *(Ukrainian S.S.R.)*

Teor. Prakt. Met., Sov. Nar. Khoz. Chelyabinsk. Ekon. Admin. Raiona, Nauch.-Issled. Inst. Met.
Teoriya i Praktika Metallurgii, Sovet Narodnogo Khozyaistva Chelyabinskogo Ekonomicheskogo Administrativnogo Raiona, Nauchno-Issledovatel'skii Institut Metallurgii *(U.S.S.R.)*

Terapia (Milan)
Terapia (Milan) *(Italy)*

Terapia (Turin)
Terapia (Turin) *(Italy)*

Thin Solid Films
Thin Solid Films *(Netherlands)*

Thoraxchir. Vask. Chir.
Thoraxchirurgie und Vaskulaere Chirurgie (formerly Thoraxchirurgie) *(West Germany)*

Tien Shih Chieh
Tien Shih Chieh (Electrical World) *(China)*

Tohoku Daigaku Senko Seiren Kenkyusho Iho
Tohoku Daigaku Senko Seiren Kenkyusho Iho (Bulletin of the Research Inst. of Mineral Dressing and Metallurgy, Tohoku University) *(Japan)*

Tokyo Astron. Bull., Ser. II
Tokyo Astronomical Bulletin, Series II *(Japan)*

Tokyo Daigaku Uchu Koku Kenkyusho Hokoku
Tokyo Daigaku Uchu Kenkyusho Hokoku (Bulletin of the Institute of Space and Aeronautical Science, University of Tokyo) *(Japan)*

Tokyo Toritsu Eisei Kenkyusho Kenkyu Hokoku
Tokyo Toritsu Eisei Kenkyusho Kenkyu Hokoku (Report of Tokyo-to Lab. for Medical Sciences) *(Japan)*

Tonind.-Ztg. Keram. Rundsch.
Tonindustrie-Zeitung und Keramische Rundschau *(West Germany)*

Trans. Amer. Ophthalmol. Soc.
Transactions of the American Ophthalmological Society *(Canada)*

Trans. Indian Ceram. Soc.
Tranactions of the Indian Ceramic Society *(India)*

Trans. Ing.
*Transactions. Ingenioeren *(Denmark)*

Transp. Stroit.
Transportnoe Stroitel'stvo *(U.S.S.R.)*

Trans. Soc. Instrum. Contr. Eng.
Transactions of the Society of Instrument and Control Engineers *(Japan)*

Trans. Soc. Pathol. Jap.
Transactiones Societatis Pathologicae Japonicae
see Nippon Byori Gakkai Kaishi

Travaux
Travaux *(France)*

Tr. Gos. Issled. Elektrokeram. Inst.
Trudy Gosudarstvennogo Issledovatel'skogo Elektrokeramicheskogo Instituta *(U.S.S.R.)*

Tr., Gos. Nauch.-Issled. Proekt. Inst. Splavov Obrab. Tsvet. Metal.
Trudy, Gosudarstvennyi Nauchno-Issledovatel'skii i Proektnyi Institut Splavov i Obrabotki Tsvetnykh Metallov *(U.S.S.R.)*

Tr. Inst. Biol., Akad. Nauk SSSR, Ural. Filial
Trudy Instituta Biologii, Akademiya Nauk SSSR, Ural'skii Filial *(U.S.S.R.)*

Tr. Inst. Met. Obogashch., Akad. Nauk Kaz. SSR
Trudy Instituta Metallurgii i Obogashcheniya, Akademiya Nauk Kazakhskoi SSR *(Kazakh S.S.R.)*

Tr. Leningrad. Tekhnol. Inst. Tsellyul.-Bum. Prom.
Trudy Leningradskogo Tekhnologicheskogo Instituta Tsellyulozno-Bumazhnoi Promyshlennosti *(U.S.S.R.)*

Tr., Mosk. Aviats. Tekhnol. Inst.
Trudy, Moskovskii Aviatsionnyi Tekhnologicheskii Institut *(U.S.S.R.)*

Tr. Mosk. Vet. Akad.
Trudy Moskovskoi Veterinarnoi Akademii *(U.S.S.R.)*

Tr. Teor. Polya
Trudy po Teorii Polya *(U.S.S.R.)*

TRW Space Log
TRW Space Log *(U. S.)*

Tumor Res.
Tumor Research *(Japan)*

Tungsten News
Tungsten News *(U.S.)*

T Z Prakt. Metallbearb.
T Z fuer Praktische Metallbearbeitung *(West Germany)*

Upr. Yadern. Energ. Ustanovkami, Sb. Statei
*Upravlenie Yadernymi Energeticheskimi Ustanovkami, Moskovskii Inzhenerno-Fizicheskii Institut, Sbornik Statei *(U.S.S.R.)*

U. S. Nav. Inst., Proc.
United States Naval Institute, Proceedings *(U. S.)*

Vector (Baltimore)
Vector (Baltimore) *(U. S.)*
Ved. Pr. Vyzk. Ustavu Vet. Lek. Brne
Vedecke Prace Vyzkumneho Ustavu Veterinarniho Lekarstvi v Brne (superseded by Documenta Veterinaria) *(Czechoslovakia)*
Vestn. Cesk. Spolecnosti Zool.
Vestnik Ceskoslovenske Spolecnosti Zoologicke *(Czechoslovakia)*
Vestn. Leningrad. Univ., Ser. Biol.
Vestnik Leningradskogo Universiteta, Seriya Biologii *(U.S.S.R.)*
Vestn. Mosk. Univ., Ser. IV. Geol.
Vestnik Moskovskogo Universiteta, Seriya IV. Geologiya *(U.S.S.R.)*
Vodosnabzh. Sanit. Tekh.
Vodosnabzhenie i Sanitarnaya Tekhnika *(U.S.S.R.)*
Vojnosanit. Pregl.
Vojnosanitetski Pregled *(Yugoslavia)*
Volt, Elec. Trade Mon.
Volt, Electrical Trade Monthly *(Japan)*
Vop. Eksp. Klin. Radiol., Khar'kov. Inst. Med. Radiol.
Voprosy Eksperimental'noi i Klinicheskoi Radiologii, Khar'kovskii Institut Meditsinskoi Radiologii *(Ukrainian S.S.R.)*
Water Res.
Water Research (supersedes in part Air and Water Pollution) *(England)*
Water Waste Treat.
Water and Waste Treatment *(England)*
Weld. Res. Counc. Bull.
Welding Research Council Bulletin *(U. S.)*
Wiad. Hutn.
Wiadomosci Hutnicze *(Poland)*
Wien. Z. Inn. Med. Grenzgeb.
Wiener Zeitschrift fuer Innere Medizin und ihre Grenzgebiete *(Austria)*
Wiss. Z. Ernst-Moritz-Arndt-Univ. Greifswald, Math.-Naturwiss. Reihe
Wissenschaftliche Zeitschrift der Ernst-Moritz-Arndt-Universitaet Greifswald, Mathematisch-Naturwissenschaftliche Reihe *(East Germany)*
Wiss. Z. Humboldt-Univ. Berlin, Math.-Naturwiss. Reihe
Wissenschaftliche Zeitschrift der Humboldt-Universitaet zu Berlin, Mathematisch-Naturwissenschaftliche Reihe *(East Germany)*
Wonjaryogwon. Yon'gu Nonmun Chip
Wonjaryogwon. Yon'gu Nonmun Chip
see **J. Nucl. Sci. (Seoul)**
Wu Hsien Tien
Wu Hsien Tien (Radio) *(China)*
Yadern. Priborostr., Nauch.-Tekh. Sb.
Yadernoe Priborostroenie, Nauchno-Tekhnicheskii Sbornik *(U.S.S.R.)*
Yakugaku Kenkyu
Yakugaku Kenkyu (Japanese Journal of Pharmacy and Chemistry) *(Japan)*
Yuan Tzu Neng
Yuan Tzu Neng (Atomic Energy) *(China)*
Zap. Leningrad. Gorn. Inst.
Zapiski Leningradskogo Gornogo Instituta *(U.S.S.R.)*
Zem. Beton
Zement und Beton *(Austria)*
Zentralbl. Neurochir.
Zentralblatt fuer Neurochirurgie *(East Germany)*
Z. Ernaehrungswiss., Suppl.
Zeitschrift fuer Ernaehrungswissenschaft, Supplemente *(West Germany)*
Zh. Org. Khim.
*Zhurnal Organicheskoi Khimii *(U.S.S.R.)*
Z. Immunitaetsforsch., Allergie Klin. Immunol.
Zeitschrift fuer Immunitaetsforschung, Allergie und Klinische Immunologie *(West Germany)*
Z. Kinderheilk.
Zeitschrift fuer Kinderheilkunde *(West Germany)*
Z. Math. Phys.
Zeitschrift fuer Mathematik und Physik *(East Germany)*
Z. Mikrosk.-Anat. Forsch.
Zeitschrift fuer Mikroskopisch-Anatomische Forschung (Abt. 2 of Jahrbuch fuer Morphologie und Mikroskopische Anatomie) *(East Germany)*
Zool. Zh.
Zoologicheskii Zhurnal *(U.S.S.R.)*
Z. Phys. Chem. B
Zeitschrift fuer Physikalische Chemie. Abt. B *(Germany)*
Z. Psychol. Physiol. Sinnesorg.
Zeitschrift fuer Psychologie und Physiologie der Sinnesorgane *(East Germany)*
Z. Sinnephysiol.
Zeitschrift fuer Sinnephysiologie *(East Germany)*
Z. Tech. Ueberwach.
Zeitschrift Technische Ueberwachung *(Austria)*
Z. Urol. Nephrol.
Zeitschrift fuer Urologie und Nephrologie *(East Germany)*

☆U. S. GOVERNMENT PRINTING OFFICE: 1968—305-453/27

NOTICE

A title page for Volume 22, Numbers 7– 12, is included at the back of this issue for use in binding those issues.

CORRECTIONS

NSA Vol. 20, No. 12, Abst. No. 21470, lines 5 through 11 should read: The main factors that determine the three-dimensional dose distribution in samples irradiated by electron beams are discussed. These factors include stopping power, straggling, and nuclear scattering. The linear accelerator and associated irradiation facilities at Riso are described, and measurement of the beam parameters is outlined. Dose distribution curves as a function of depth in water, aluminum, copper, and iron are illustrated. Boundary problems that occur near the edges of the sample and result in dose inhomogeneity are considered. Methods to overcome these boundary problems are outlined.

NSA Vol. 20, No. 24, Author Index, SAMSONOV, G. V., Production and properties of rare earth phosphides, should have abstract number 20: 45686 instead of 20: 45685.

NSA Vol. 22, No. 6, Abst. No. 11081, lines 1 & 2 should read: PHASE EQUILIBRIA IN SYSTEMS OF SAMARIUM OR EUROPIUM MONOXIDES AND SILICA. Bondar,